THE JOURNAL OF ENGINEERING EDUCATION

Published monthly (except during July and August) by the Society for the Promotion of Engineering Education

Published under the Supervision of the Publication Committee.
O. J. Ferguson, K. T. Compton, F. L. Bishop, Editor, University of Pittsburgh.
Published at Prince and Lemon Sts., Lancaster, Pa.

Entered as second-class matter at the Post Office at Lancaster, Pa., under the Act of August 12, 1912.

New Series
Vol. XXX, No. 9

MAY, 1940

Subscription Price, $3.00 per year. Single Copies, 50 cents

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SECOND SUMMER CONFERENCE ON ENGINEERING EDUCATION

July 8–20, 1940, University of New Hampshire, Durham, N. H., George W. Case, Chairman

The conference will deal with problems connected with the building up of an engineering curriculum to meet modern needs. Detail measures necessarily taken to build such a curriculum will be discussed with the hope of finding solutions to the problems involved. The conference which will be under the joint sponsorship of S. P. E. E. and the University will be for teachers of engineering and allied courses and men in practice interested in the training of young men for engineering positions. The plan includes one- and two-day discussions of selected topics, presided over by leaders in industry and in professional engineering practice and education.

Since the conference will be held during the period of the Summer School, the University dormitories and dining hall facilities will be available at the same low rates as apply to Summer School students. The fee charged will be $15.00 for the purpose of reimbursing the University for expenditures of the major items of the cost of the conference.

INVITATION FROM OREGON STATE COLLEGE

The School of Engineering of Oregon State College of Corvallis, Oregon, extends a cordial invitation to all members of the S. P. E. E. to visit the College on their way to or from the national convention at Berkeley in June.

The Northwest has several places of interest, notably Bonneville and Grand Coulee, which may attract members of the S. P. E. E. to our Pacific Northwest, and as we are on the direct route, a convenient opportunity would be presented for a visit here.

R. H. DEARBORN, *Dean,*
School of Engineering

MOTOR TOURING TO THE BERKELEY CONVENTION

(A BRIEF ACCOUNT OF THINGS TO SEE EN ROUTE AND WHILE IN CALIFORNIA)

By L. C. UREN

Professor of Petroleum Engineering, University of California

S. P. E. E. members and their families who enjoy motoring will have a rare opportunity to combine a trip to the California convention with a vacation tour that will be long remembered. With restrictions on foreign travel occasioned by war-time conditions abroad, this is the year to make that long-contemplated motor trip to the West Coast, attend the Berkeley convention and "see America" en route. If two or more persons are traveling together, the cost per person is no more than by other methods of travel and the points of interest in California and en route may be more conveniently and pleasurably visited in one's own car. It is hoped that this brief article may be helpful to members not familiar with the West, in suggesting places to be visited and things to be seen on such a trip.

If you are one of those who have been reluctant to undertake a motor tour of the West because of visions of great open spaces without convenient accommodations, repair and service facilities, and with many hundreds of miles of unpaved, rough and dusty roads, be assured that the entire trip may now be made without ever leaving a well-paved highway; that motoring facilities are everywhere provided and that comfortable accommodations will be available at the end of each day's journey. In short, if one can accustom himself to driving from 250 to 500 miles per day, with occasional days off for rest and recreation, such a trip may be entirely pleasurable and may be accomplished within the time and at a cost no greater than that normally anticipated by most academic people for vacation purposes.

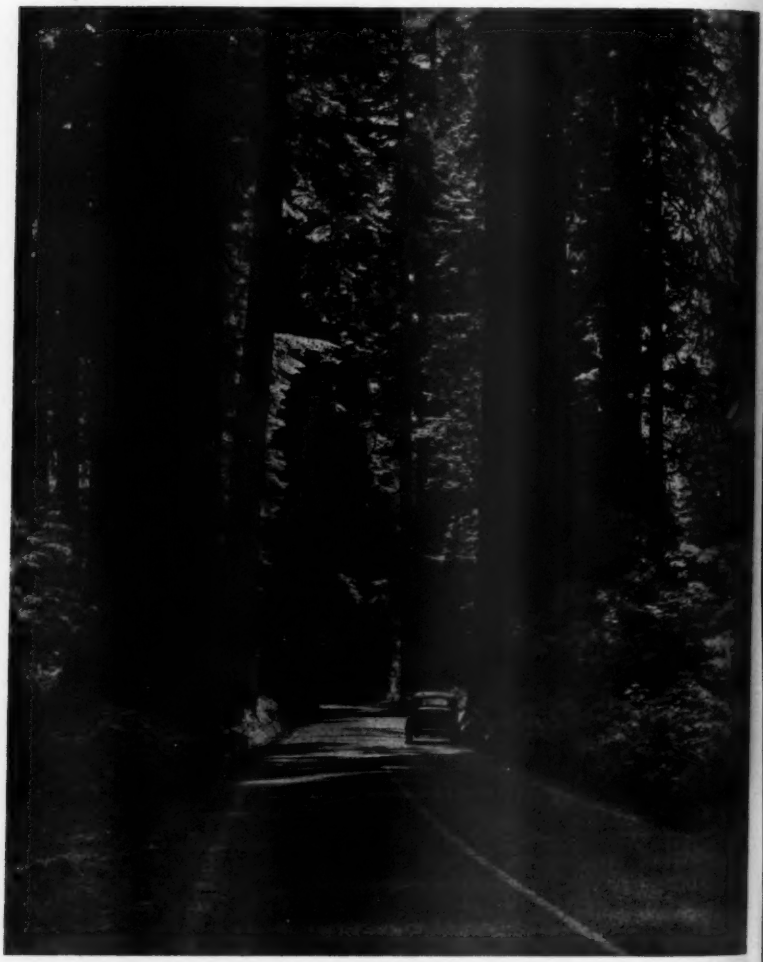
The route that one might select in motoring to Berkeley will, of course, depend upon the starting point and the section of the country that one might wish to see en route. Generally, it will be possible to plan to travel west by one route and return by another, following a "circle tour" that will include as many points of interest as possible. Members living in the southern states will find their shortest route through Texas, New Mexico and Arizona into southern California, thence north to the San Francisco Bay area,

in which the University of California at Berkeley is situated. Two routes are possible: Highways 90–8—70–101 through Houston, San Antonio, El Paso, Phoenix and Los Angeles to Berkeley; and the "Santa Fe Trail" (Highways 66–101) through Tulsa, Albuquerque, Flagstaff, Barstow and Los Angeles to Berkeley. The

BOULDER DAM. (Courtesy of National Park Service.)

latter route traverses generally higher elevations and is likely to be cooler than the more southern route. The Grand Canyon of the Colorado, Boulder Dam and Death Valley are conveniently accessible on short laterals from Highway 66, while Carlsbad Caverns in southeastern New Mexico, a visit over the border in Old Mexico at El Paso, and some of the world's largest copper mines are points of interest along highways 90–80–70. The drive from Houston or Tulsa to Berkeley may be made without undue effort in five days or less if one is accustomed to driving about 350 or 400 miles per day.

Motorists driving to California from New England and the Middle West will, in most cases, prefer to avoid the summer heat

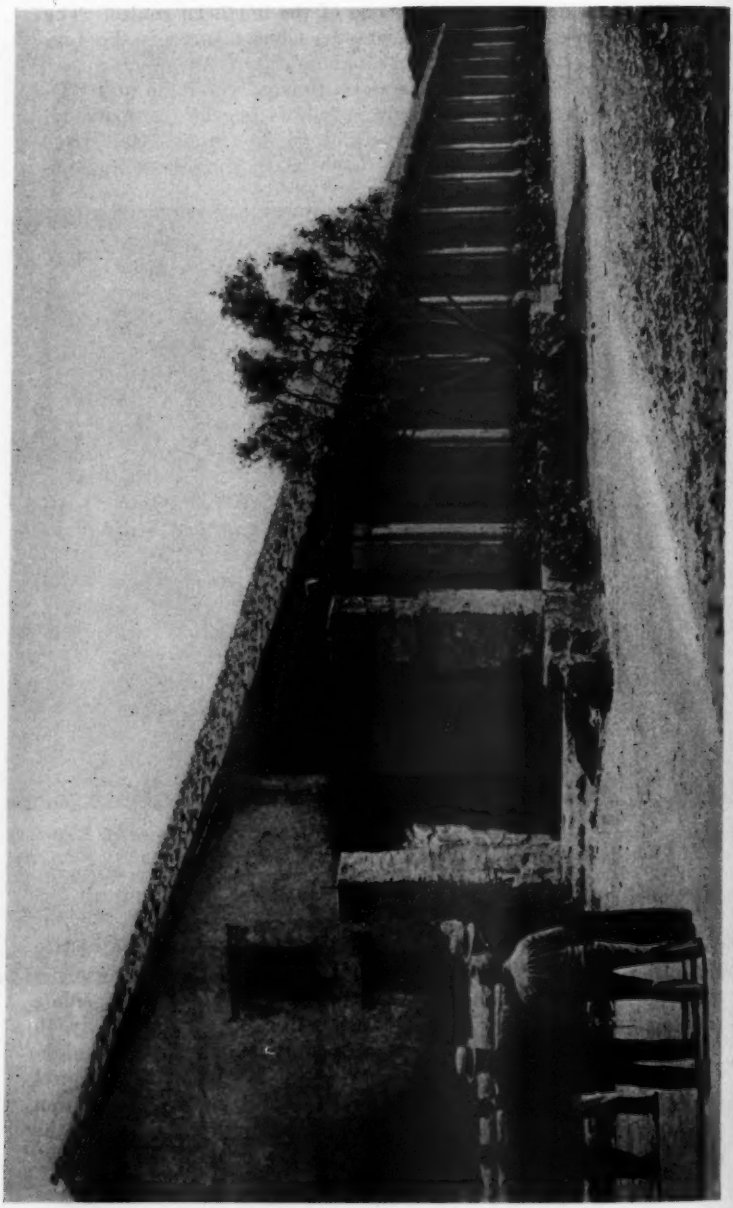


"THE AVENUE OF THE GIANTS," north of Dyerville, Humboldt County, Calif.
(Courtesy of "Save-the-Redwoods League.")

of the southern deserts by taking one of the northern routes. The shortest and most direct route from the Chicago area is the Lincoln Highway (Routes 30–40), through southern Wyoming, northern Utah and Nevada, into central California, via Reno and Sacramento to Berkeley. This highway follows one of the principal "emigrant trails" of pioneer days and passes through Salt Lake City with its Mormon Tabernacle, Utah State University and im-

HUGE PRIMITIVE REDWOOD COLUMNS characterize the new Mill Creek Redwoods State Park, northeast of Crescent City, Calif., where 6,700 acres of superb forest has recently been made part of the State Park System. (Courtesy of "Save-the-Redwoods League.")

portant mining and metallurgical industries. Denver and Estes and other Rocky Mountain parks may be visited on a short detour south from Cheyenne; and Lake Tahoe, one of California's principal resort centers, is but a few miles south of Highway 40 from Truckee, on the California-Nevada boundary. This highway and alternate route 50 from Truckee to California's capitol city, Sacramento, traverses an interesting and picturesque section of the Sierra Nevada Mountains, passing through a number of the



LA PURISIMA MISSION. (Courtesy of State of California, Dept. of Natural Resources, Division of Parks.)

pioneer gold mining camps of this region. The trip from Chicago to Berkeley via the Lincoln Highway can be comfortably made in six days.

Visitors from the Pacific Northwest will journey southward either on interior Highway 99 or on coast Highway 101. Each possesses attractions that one making a round trip cannot afford to miss. Eastern visitors planning a "circle tour" will probably find more of scenic interest on Route 101 in the event that the return journey is planned via the Pacific Northwest. This route traverses the world-famous Redwood Highway and skirts the Oregon and Washington coast line for a distance of nearly 500 miles: in all, one of America's most attractive motor experiences. An alternate plan, preferred by many, is that of turning eastward from Highway 101 at Astoria, thence to Portland and then continuing northward on interior Highway 99. From Highway 99, interesting laterals explore the Columbia River and Mount Hood region and farther north, southeast of Tacoma, is beautiful Mount Rainier National Park. Two hundred miles of travel northward from Seattle will enable the motorist to visit the Canadian cities of Victoria and Vancouver and to explore some of the many miles of inland shore line along Puget Sound and the Straits of Georgia.

Eastern and middle-western tourists returning home from the Pacific Northwest will find their best route via Highway 10, across the Cascade Range to Spokane, visiting nearby Grand Coulee Dam, and thence, continuing eastward on Route 10, or farther north on Route 2. The latter enables one to visit Glacier National Park. Here the drive over Logan Pass affords views of some of America's finest mountain scenery. Route 10, via Butte, leads to the Livingstone or northern entrance to Yellowstone, America's favorite national park. After viewing the wonders of Yellowstone, one may return to Highway 10 via the recently completed Silver Gate or northeastern entrance to Laurel, Montana: an excellent highway which attains an elevation of nearly 11,000 feet and affords many excellent views of this mountainous region. Tourists returning southward from Yellowstone will find Route 20, via Cody, Thermopolis, Casper, Cheyenne and Denver, one of more than passing interest.

The S. P. E. E. visitor in California should reserve at least a few days before or following the Berkeley convention, for visits to some of California's tourist attractions. The Golden Gate International Exposition, now in its second year, is only 30 minutes' drive from the Berkeley Campus. San Francisco's Golden Gate Park, Presidio, Ocean Shore and Skyline drives are also of immediate interest. A circle drive around San Francisco Bay, including the Marin Peninsula and passing over three of the world's

La Purisima Mission. (Courtesy of State of California, Dept. of Natural Resources, Division of Parks.)

largest bridges, is a half-day trip that no visitor should miss. Yosemite National Park and the Big Trees are but a five- or six-hour drive from Berkeley; Lake Tahoe about the same; the Monterey Peninsula, three or four hours. If one is not returning home by way of the Pacific Northwest, a single day's drive northward from Berkeley to Eureka or Crescent City will include the best of California's Redwood Highway. Southern California, with its many tourist attractions, is but a ten- or twelve-hour drive from Berkeley, and two excellent highways are available. However, the tourist will find the Coast Highway (Route 101), via Santa Barbara, the most comfortable during the summer season. Detailed information concerning these and other recreational and industrial tours in California will be available from the Convention's Entertainment and Trips Committee at the time of registration.

California and the West are calling!

INSTRUCTIONAL METHODS IN ENGINEERING—A BIBLIOGRAPHY

Prepared for the
Committee on Instructional Methods,
Society for the Promotion of Engineering Education, February, 1940

COMPILED BY

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Assistant Dean of Engineering, Northeastern University, Boston, Massachusetts

S. P. E. E. COMMITTEE ON INSTRUCTIONAL METHODS, 1939–1940

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FOREWORD

Among the suggestions contributed to the early deliberations of the Committee on Instructional Methods in the fall of 1939 was the idea of reviewing the Journals of Engineering Education for the purpose of bringing clearly into view exactly what aspects of engineering teaching had been dealt with recently, and the adequacy and extent of these discussions, with the aim of discovering what phase of the matter seemed most needful of attention by the Committee this year.

In order to explore the possibilities of this proposal, Professor William C. White of Northeastern University was asked to undertake the preparation of a bibliography of papers published in the JOURNAL which appeared to treat specifically of methods of engineering teaching. An effort was made to include only papers which related directly to teaching technics. After this list had been compiled and submitted to the members of the Committee for comment and criticism, it seemed worth while to proceed with the preparation of brief abstracts of each title.

No critical evaluation of the papers has been attempted but an endeavor has been made to prepare a careful and brief summary. No claim is made for completeness in this bibliography, but it is believed that most of the significant contributions in the field of engineering teaching methods during the period from 1926 to 1939 which appeared in the JOURNAL have been included.

In view of the many worth while ideas and useful technics contained in these papers it seemed to the Committee that the bibliog-

raphy should be made available to engineering schools throughout the country and that the material might prove to be particularly serviceable to young instructors who are just beginning their teaching careers in the field of engineering. A simple arrangement of the material has been followed: the titles are presented in the order of their appearance in each volume, beginning with Volume 29, 1938–1939, and going back as far as Volume 17, 1926–1927. Classified subject matter and author indexes have been prepared in order that those concerned with special aspects of teaching may be able quickly to find the articles in which they are interested.

It is our hope that this bibliography may serve to focus the attention of engineering teachers upon the wealth of material on teaching methods that is available to them in the recent publications of our Society.

CARL S. ELL, *Chairman*
Committee on Instructional Methods

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  B. Philosophical and General
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II. *Visual Aids* (Diagrams, models, films, museums, demonstrations, slides, trips)
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Vol. 29—1938–1939

1. Morgan, T. H. A Program for Unification and Correlation in Engineering Education, 1; 73.

Explains the unification principle and indicates how it may be applied to the engineering curriculum. By this method principles and applications are the starting point of instruction. Coördination between physical sciences and mathematics is discussed. As an example of coördination within an engineering department the unification of the work in electrical engineering is considered. Non-science and non-technical work is also considered. Finally, the idealistic and practical aspects of this plan are indicated.

2. Dodge, H. L. Instructional Methods, 3; 198.

High points in the following papers are noted: (1) Tomlinson's "The Use of Motion Pictures in Engineering Education"; (2) Davis, on English (this and the remaining papers are concerned with methods of stimulating interest in these cultural fields); (3) Hart, on Speech; (4) Lake, on Economics; (5) Correll, on History; and (6) Schweiger, on Government.

3. Ketchum, R. B. Uses of Microfilms in Engineering Education, 4; 284.

An up-to-date collection of microfilms is urged as a means of bridging the gap between textbooks and real up-to-date engineering practice. A microfilm library to supplement each course is recommended. Other uses of microfilms are indicated.

4. KEREKES, F. Scope and Organization of a Sequence of Courses in Structures in Relation to the Civil Engineering Curriculum, 4; 299.

Personal and social effectiveness and the engineering method of thought are analyzed as the objectives of instruction. Material on structural types, loads, stress analysis, and design is organized and presented with suggested activities. The sequence and contents of structural courses are outlined.

5. DAVIS, H. E. Research in Relation to Teaching, 5; 400.

The advantages and disadvantages of research are listed in the discussion of the relation of research to teaching. Undergraduate thesis work is considered as an important informal method of instruction. Suggestions to aid the instructor in supervising projects are offered.

6. RAEDER, W. Undergraduate Theses as a Means of Developing Research Initiative Among Faculty and Students, 7; 501.

Use of the undergraduate thesis as a means of developing research initiative is urged. Close faculty supervision is recommended for the benefit of both student and faculty.

7. MITCHELL, A. The Opportunity to Instill Engineering Spirit in Freshmen as Offered in the Teaching of Engineering Drawing, 9; 728.

In a general way the inspirational value of engineering drawing is indicated. Mention is made of the objectives of the course, of creating interest, and of pointing out practical applications. The inspirational value of descriptive geometry receives consideration. In the ensuing discussion, Professor Rowe elaborates further on the engineering spirit and the outcomes of drawing and geometry. Professor Mann outlines the plan he uses, describing an interesting project for superior students and indicating how the engineering spirit and interest may be instilled. Variations in techniques described include projects, the use of films, evening meetings, and trips.

8. TOMLINSON, G. E. The Use of Motion Pictures in Engineering Education, 9; 739.

Practical suggestions for the use of motion pictures in supplementing instruction are presented. Recommends the establishment of a central distribution system and indicates the functions of such an agency. The problems involved in the preparation, selection, distribution, and use of films are considered.

9. CORRELL, C. M. On Teaching History to Engineering Students, 9; 745.

Suggestions for organizing and presenting history so as to stimulate the interest of engineering students are offered. Emphasis is placed on the practical value of knowledge of history.

10. LAKE, WILFRED S. Vitalizing Instruction in Economics for Engineering Students, 9; 751.

Stressing the importance of intrinsic rather than extrinsic interest, the author discusses various sources of intrinsic interest. Suggestions included involve the use of the daily newspaper, the use of students' experiences, and careful selection of subject matter.

11. SWEIGERT, R. L. Do Instructional Methods Used in the Manufacturing Processes Laboratories Contribute to Trade Training or to Engineering Education, 10; 785.

The objectives of the manufacturing processes laboratory are listed. The methods used in mechanical engineering laboratories are presented to be adapted for use in the processing laboratories.

12. SCHNEIDER, FRANZ. Educational Value of Scholarship Societies, 10; 831.

The educational value and advantages of scholarship societies are discussed from the point of view of both the student and the university or society in general. Concrete suggestions for improving honor societies are offered.

13. THOMAS, F. H. Machine Tool Laboratory Instruction in the Engineering Curricula, 10; 861.

After indicating the need for shop instruction, the author urges revision of the subject matter and methods of teaching and offers suggestions along that line. Expresses preference for material which can be assembled into a working model rather than one piece projects. Emphasizing the instructional part he asserts that the how and why are more important than the finished product.

14. DEGLER, HOWARD E. Combined Engineering Laboratories Correlated with Mechanical Engineering, 10; 880.

After indicating how the mechanical engineering laboratory "cuts across" the units of the other departments, Professor Degler presents reasons for combining the engineering laboratory work. Asserting the laboratory work has become stereotyped and less effective, he offers eight specific suggestions for its rejuvenation. The advantages and disadvantages of the combined engineering laboratory are then considered. Stresses the need for correlation, if not fusion, of laboratory work.

15. DAWLEY, E. R. Undergraduate Theses as a Means of Developing Research Initiative Among Faculty and Students, 10; 902.

Views opposing and favoring undergraduate theses are presented. Problems of administering undergraduate theses are considered. Suggestions and conclusions in favor of theses are offered.

16. FURNAS, C. C. Chemical Engineering for Seniors, 10; 908.

The procedure described stresses the importance of learning where and how to get information rather than merely learning information. The equipment and processes used in the laboratory are indicated. The methods used involving the problem approach to the subject are described. The procedure in the projects course and the variety of projects are indicated. Finally, the nature and conduct of a plant design course are reviewed.

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17. POTTER, A. A. Effective Teaching, 2; 110.

Describes the attributes that make for effective teaching and enumerates desirable traits for the good teacher. Recommends research by teachers as a means of increasing their inspirational value. Considers teaching an art offering greater rewards than the mere pay check.

18. SHREVE, R. NORRIS. Unit Processes in Organic Technology, 4; 299.

Considers unit processes necessary as a means of emphasizing the common or unitary principles among the numerous facts and principles encountered. Points out evidences of the unitary features of industrial chemistry and the advantages of the unit process way of study. Describes the case system used at Purdue. Maintains it aids the student in forming generalizations.

19. SELVIDGE, R. W. Plan for Organizing a Course, 4; 310.

Places the responsibility for learning directly on the student by telling him what he is expected to learn from each assignment. Offers suggestions for selecting, organizing, and presenting subject matter. Lists some learning units for an elementary course in heat engineering. Presents an assignment on Boyle's Law as a sample of the organization of a learning unit. Offers plans for organizing laboratory work and includes a sample chart of the experiments and the learning units involved in each.

20. KRATHWOHL, WM. C. Methods of Effecting Better Coördination Between Mathematics and Technical Engineering Courses, 8; 517.

Recommends mutual help and coöperation between mathematicians and engineers and indicates how mutual help can be secured. Offers 12 specific suggestions as to how mathematicians can help engineers and 12 ways in which engineers can help mathematicians. Advocates greater awareness and knowledge of the other's field.

21. DRAFFIN, J. O. Development of Some Concepts of Mechanics, 8; 563.

Presents the development of two concepts of mechanics, equilibrium, and the motion of bodies. Follows an historical approach in showing how these concepts developed. Advocates presenting the continuing, growing, thinking point of view of the progress in the development and application of principles.

Vol. 27—1936–1937

22. CONNELLY, J. R. Can Something of Engineering Education be Learned from the Example of James Watt?, 2; 140.

Following the steps taken by James Watt in developing the steam engine a sample of problem solving, including awareness of the problem, investigation, experimentation, reasoning, and application, is presented. Objects to methods of today whereby student is given theories and formulas to master and later to apply. Preferring the problem-solving approach, recommends specific changes in engineering education.

23. GOODIER, J. N. Engineering Education at Cambridge University, England, 5; 381.

Describes the Cambridge system, which is free from any technical specialization. Traces the steps followed by the beginning student indicating the choices before him and the required studies. Bears in mind throughout the two-fold aim—technical development and civic-social development, and points out the general freedom of the system.

24. KRYNINE, D. P. Aims and Methods of Higher Technical Edution in Continental Europe, 5; 388.

Surveys the several systems of higher technical education in France, Germany, Russia. Includes a review of their admission policies, their research and post-graduate work, their teaching personnel, and their aims. One section is devoted to their methods of teaching.

25. GRANT, E. L. Practicable Objectives in Teaching Engineering Economy, 8; 580.

Outlines five steps involved in an engineering economy study and indicates ways in which such studies may go wrong. Offers

specific suggestions for teaching engineering economy and recommends a separate course for effective teaching of engineering economy.

26. ROGERS, H. S. Teaching of Basic Courses, 9; 672.

Differentiates basic courses from applied and informational courses by their emphasis on principles and elements. Then discusses the organization of basic subjects, the nature of basic principles, the objectives of instruction, the mastery of basic principles, and methods of instruction. Indicates the stages to be passed through in attaining mastery, and bases his methods on the process of inductive thinking.

27. AHLQUIST, R. W. Some Laboratory Technique Demonstrating Kirchoff's Laws, 10; 729.

Describes a circuit of five known resistors forming an unbalanced wheatstone bridge as a means of studying Kirchoff's Laws and indicates procedure followed at University of Pittsburgh. By simplifying the equipment and eliminating some sources of error, enables correlation between classroom and laboratory.

28. KEREKES, FRANK. Teaching Applied Courses, 10; 747.

Presents in outline form the elements of engineering proficiency and the elements of teaching applied courses. The latter includes considerations of the thinking process, functional objectives, and specific techniques for realizing these objectives.

29. INGERSOLL, L. R. Physics Museum at Wisconsin (Full Title—The Wisconsin Physics Museum and Its Usefulness in Teaching Physics to Engineering Students), 10; 790.

Divides the material on exhibition into two classes—(1) still exhibits as charts, transparencies, apparatus; (2) exhibits which "work." Describes many of the exhibits that work including the Foucault pendulum, the gyroscope, hydraulic models, air pressure experiments, and others from the fields of electricity, sound, heat, and light. Indicates the popularity and utility of such a museum.

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30. MAGOUN, F. A. The Aims and Techniques of Teaching, 6; 452.

Accepts the definition of education as "a system of habits for worthwhile growth" and considers the following questions: (1) what is a habit? (2) what are the basic habit patterns which characterize an educated man? (3) how can he be given these habits? and (4) what tests will show when he has acquired them? Presents an outline of habits of body, intellect, and personality char-

acteristic of an educated man. Stresses the importance of personality, emotions, and the *whole* man. Discusses the means of habit formation and its implications, offering specific suggestions.

31. GRANTHAM, G. E. The Physics Laboratory Report for the Engineering Student, 6; 474.

Declares much valuable time is wasted by requiring formal reports affecting seriously the outcomes of laboratory work. Proposes that the instructor spend 15 minutes with the student discussing the experiment while it is being performed. Describes the procedure for freshmen at Cornell, for whom the formal report has been omitted.

32. OGBURN, S. C., JR. A Study of Chemical Engineering Laboratory Instruction in the United States, 7; 511.

Presents a summary of the results obtained through a questionnaire replied to by 93 institutions. The results are presented question by question and include data on the organization of laboratory work, methods of laboratory instruction, unit operations studied, equipment used, laboratory reports, and general discussion. Verbatim remarks and opinions considered useful are also reported.

33. KINTNER, R. C. A Study of Chemical Engineering Unit Operations Laboratory Directions, 7; 525.

Based on data from the chemical engineering questionnaire, reports on the tangible objectives of unit operations teaching. Also presents a summary of what is included in direction sheets for laboratory work and what experiments are written up. Finally, a summary of the results and conclusions formed are included.

34. KOFFOLT, J. H., AND WITHROW, J. R. Laboratory Methods and Equipment Used in Teaching Distillation, 7; 531.

Presents a detailed description of the equipment used in teaching distillation. The flexibility of the distillation unit is shown by listing 11 different ways of operating it. Their squad system and procedure followed by the students are described. Finally, the objectives attained from each problem are enumerated.

35. RANDOLPH, E. E. The Value of Industrial Inspection Trips to Chemical Engineering Laboratory Work, 7; 536.

Briefly reviews the present status of chemical engineering training and notes some of the duties of the chemical engineer. Points out the need for plant studies and describes a visit to a talc mine, a thorough survey of a city gas plant, and a senior inspection and study trip. Indicates the benefits of such trips to the student.

36. NAETHER, CARL. Teaching the Course in Technical Writing, 8; 647.

Outlines the procedures for a course in technical writing. Proposes coöperation between engineering and English departments; thus a student presents the write-up of a field trip or a technical paper to the English department. Claims the course in technical writing receives greater enthusiasm and effort and creates a better attitude among the students.

37. FROCHT, M. M. The Place of Photoelasticity in Engineering Instruction, 8; 656.

Shows the merits of photoelasticity as an experimental method of stress analysis, pointing out several basic assumptions in the conventional treatment of stress analysis that do not hold. Gives specific examples to show the shortcomings of the elementary engineering theory. Indicates the nature of the data obtainable from photoelasticity, its major applications, and its reliability. Concludes that photoelasticity is an important tool in engineering instruction capable of eliminating the present weaknesses in stress analysis.

38. SEELEY, W. J. Applications of Mathematics to Electrical Engineering, 9; 741.

Maintains that there is a need for the mathematics teacher to inspire the minds of engineering students with the philosophy of mathematics to balance the utilitarian view of mathematics obtained from the engineering teacher. Regretting the fact that students use a table of Bessel's Functions without knowing what these functions are, merely accepting them in good faith, he proposes more work on the origin or derivation of the various functions. He presents examples of interesting mathematical transformations and processes designed to develop greater appreciation of the philosophy of mathematics, and recommends the operational calculus "as a sort of dessert to the whole course of electrical engineering."

39. BOELTER, L. M. K. Mechanical Engineering Laboratory Practice, 9; 747.

Emphasizes the fact that the basic laws of science apply for a given set of conditions, and divergences are not ascribable to discrepancies between theory and practice. Cites the dangers of what he calls the "macroscopic" view in mechanical engineering laboratory practice and prefers the "microscopic" view which considers all the variables and permits true idealization of the system. Favors an experimental mode of attack permitting student initiative in the engineering laboratory. Presents an outline of unit operations in mechanical engineering and the sequence to be fol-

lowed, designed to facilitate the experimental approach involving analysis, synthesis, and integration.

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40. McCULLY, H. M. Slide Rule Practice as an Interest Factor in Engineering Drawing, 1; 54.

The advantages, both inherent and indirect, of the use of slide rule are indicated. Based on the results of a survey, a chart showing where and how a slide rule may be used in the various courses is presented. Consideration is given to the slide rule as a symbol, for the beginning student, of a successful engineer. The place to teach and the method of teaching the slide rule are discussed. Special emphasis is given to the slide rule as an interest factor in the study of engineering drawing. Practical suggestions as to the selection and use of a slide rule are offered.

41. HILL, A. M. A Mechanical Temperature Entropy Diagram, 2; 166.

A model to illustrate the sequence of events represented by a temperature-entropy diagram is described. The materials used and directions for constructing the model are included.

42. OGBURN, S. C., JR. Chemical Engineering Laboratory Texts and Notebooks, 3; 219.

This paper is an account of the methods and objectives followed by the author in assigning experimental work to chemical engineering students. His plan calls for the work to be performed in squads of three men. The problems used and the basis for selecting them are indicated. The procedure to be followed and the general form of the laboratory report are described. Specific instructions are favored for the beginning student, these giving way to merely useful suggestions for the graduate student.

43. ALBERT, A. L. Standards for Laboratory Reports, 4; 297.

Recommends, especially for inexperienced students, the use of a flexible outline for formal reports and presents a "Suggested Outline." The development of a favorable student attitude towards reports is considered. Symbols, curve plotting, and various standard procedures are discussed. Valuable suggestions concerning formal and informal reports are offered for the instructor.

44. HUMMEL, J. O. P. The Use of a Laboratory in Teaching Time and Motion Studies, 6; 411.

The objectives of a time and motion study course are reviewed. Recognizing the following three divisions of time and motion study

—(1) Process Charts, (2) Motion Study, and (3) Time Study —the author discusses these, considering methods of presentation, applications, and related problems. In describing his own procedure he suggests many useful projects.

45. CASBERG, C. H. Laboratory Procedure in Teaching Machine Production, 6; 419.

After reviewing the aims of shop laboratory courses, Professor Casberg describes the procedure he employs in attaining these aims. The advantages and disadvantages of this procedure are considered. Arguments in support of the maintenance of a production laboratory are presented.

46. DODDS, J. S. Good Teaching, 7; 464.

This is an analysis of the elements that constitute good teaching. This includes in the order of importance personal character, classroom decorum, knowledge of the subject, and broad understanding of the relation of the subject to engineering and to community life. Consideration is given to the problem of grading and measuring progress.

47. ROBERTSON, B. L., AND ROGERS, T. A. Aids to the Lecture System, 7; 467.

The lecture system and its limitations are discussed. Aids to lecturing are presented under three classifications—personal presentation, technical methods, and principles of teaching. Special consideration is given to class response, which is contrasted with the formal lecture. A long list of the advantages of class response is included.

48. NEWELL, H. H. Laboratory Equipment and Practice Employed in Teaching Electronics and Electrical Communication, 8; 556.

The author presents an outline of the practice he follows. The material is presented to give a logical picture and to provide a general electrical engineering training. A sample series of experiments is listed with a discussion of the equipment and practice followed in these experiments. Mention is also made of plant visits and a student radio club.

49. MCADAMS, WM. H. Methods of Teaching Heat Transfer, 9; 595.

A concise outline of the points to be emphasized in a general course on heat transfer is offered. Suggestions as to types of problems and lecture experiments are included.

50. HOTTEL, H. C. Thermal Radiation—Subject Matter and Laboratory Technique, 9; 598.

The first and major part consists of an outline of material suitable for a course in thermal radiation including suggestions as to the assigning of problems. The rest of the paper consists of generalizations and recommendations concerning laboratory technique. Special stress is given to the avoidance of errors.

51. HOWELL, A. C. Teaching Literature to Engineers, 9; 639.

The author is especially concerned with the problem of motivating and interesting students. The plan employed at the University of North Carolina is presented. A suggested introduction which serves to review the aims of the course, to interest the students, and to stimulate thinking is offered. Specific recommendations and methods for conducting the class are included.

52. THOMPSON, J. T. Illustrating Structural Problems with the Deformeter Method of Model Analysis, 10; 696.

The deformeter method employs mechanical devices, and the author describes the two common types of devices. The modifications, uses, and applications of these devices are discussed and described in detail. Finally, there is a comparison of the two types of devices.

53. GILKEY, H. J. The Various Types of Loaded Models and Some Problems to which Their Use is Adapted, 10; 702.

A complete classification of types of models is offered, applications of each are indicated, and further references are included.

54. DRAFFIN, J. O. Laboratory Instruction in Engineering Education, 10; 727.

The past, present, and future of laboratory instruction are discussed showing the change from the symposium method to methods adapted for "mass production." He distinguishes two types of laboratory work—(1) observation of phenomena, and (2) analysis of results. Criticizing present practice, the author makes suggestions for making laboratory work more effective. He is especially concerned with developing initiative in and giving inspiration to the students.

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55. SWEIGERT, R. L. Application of Educational Philosophy to the Educational Process in a Professional Engineering Course, 3; 217.

Certain educational philosophical ideas are selected and directly applied to the educational process by Professor Sweigert. The

technique and methods developed to attain the ends dictated by these fundamental principles are described in detail. The method, after the appropriate transition stage, emphasizes individual freedom and initiative. The results of a student opinion check-up on this method are given along with representative student comments. The procedure finally evolved is described, and its results are considered. Many valuable and interesting ideas are expressed.

56. Reinsch, B. P. Psychological Principles Applied to the Learning Process in Engineering Subjects, 9; 588.

A list of 11 important aims of teaching engineering subjects is recorded. This is followed by a list of the principles of learning with illustrations of the psychological laws and aids involved. Particular methods and practices in teaching engineering subjects are reviewed to indicate how the laws of learning may be applied. Thorough study of psychology and the learning process and research in effective methods of teaching are urged.

57. Pound, J. H. Efficient Preparation of Engineering Laboratory Reports, 9; 601.

Asserting that too much time is spent on laboratory reports, Professor Pound makes recommendations for improving efficiency in this respect. Methods of attaining adequate preparation before the experiment are considered as a means of saving time in securing the data. For saving time in preparing the report itself, suggestions including standardization on form and detail and minimization of mechanical copying are offered. Various forms for presenting the material are considered with preference given to the commercial or magazine article type.

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58. Doherty, R. E. Educational Preparation for Creative Technical Engineering Leadership, 4; 309.

Asserting that the ratio of thinkers to technicians is too low, Dean Doherty urges us to develop creative leaders through the development of the scientific habit of thought. To attain this he recommends emphasizing independent constructive thought as well as knowledge and manipulative techniques. Present procedure is critically appraised, and, after a review of the five phases of the learning process, a new plan designed to attain these ends is outlined. Ideas for developing reasoning power are suggested, and the consequent cut-down of subject matter is recommended.

59. Grant, Eugene L. Methods of Teaching Economics of Engineering, 8; 602.

Based on his primary purpose, which is to give the student a

point of view that will make him look for the economic aspects of engineering situations, the author takes as the central problem of his course the answer to the question, "Will it pay?" His methods in attaining this objective are described. Questions of presentation and emphasis are discussed, and suggestive comments are offered.

60. PAYROW, H. G. Values in Seeing Things, 9; 677.

In this discussion of inspection trips consideration is given to the following: (1) the time when the trip should be taken; (2) the faculty regulations under which it should be conducted; (3) the preparation for the trip; and (4) the selection of places to visit. Included also is a student rating of various places visited.

61. DRAFFIN, J. O. Function of the Testing Laboratory in Teaching Resistance of Materials, 9; 681.

The author is primarily concerned with the problem of getting the testing laboratory to supplement the classroom instruction and to facilitate the transfer of knowledge derived from the classroom or textbook. Preferring student performance of experiments to classroom demonstration, he gives a detailed account of the function, organization, and methods of his laboratory work. Specific problems or experiments are mentioned.

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62. SLICHTER, C. S. The Self-Training of a Teacher, 2; 110.

Dean Slichter analyzes the duties and functions of the college teacher with the emphasis deliberately placed on the temper and spirit of these duties rather than on specific techniques. Useful suggestions are offered for developing the art of making a subject interesting.

63. HEDRICK, E. R. The Teaching of Trigonometry for Engineers, 4; 299 (esp. 307).

This dissertation, permeated throughout by valuable personal observations, gives consideration to the aims of teaching trigonometry, to questions regarding content (with reasons for and against), to the problem of arrangement of content, and to methods of teaching. The problems of approach, motivation, memory work, transference, relative emphases, notations, and drawings are considered.

64. HALL, JAMES A. College Training of Engineering Students for Work in Machine Design, 4; 318.

The topics to be included in a course on machine design are considered in the light of the factors in mental equipment needed by the machine designer. Various methods including the purely

analytical course, the complete layout-of-machines type, and the case system are critically reviewed. Suggestions for problems on analysis are presented. The development of a critical attitude by correlating analyses with the results of practice and research and by frequent assignment of problems is urged.

65. Brooke, W. E. College Algebra for Students of Engineering, 5; 387.

Part I consists of an outline of the course content. Part II is a consideration of teaching problems. Pointed suggestions and observations related to the teacher's function, the students' attitude, and the actual subject matter are recorded.

66. Berry, Wm. J. Analytic Geometry for Students of Engineering, 5; 393.

A compendious, detailed outline of the course content is presented. Teaching problems are then considered in the form of questions and suggested answers. Among the problems included are those of developing understanding and appreciation of principles, of coördinating geometry with other subjects, and of securing the necessary drill.

67. Huntington, E. V. Teaching the Calculus, 6; 485.

A complete and detailed outline of the course content of a course in calculus is presented. Professor Huntington makes a point of distinguishing between the use of a theorem and the proof of it. Typical of Professor Huntington, stress is placed on the attitude of demanding proof rather than the straight acceptance of the material with the feeling that only the tools and not the rigor are needed. The point of view of saving time is maintained. Many valuable examples, observations, and recommendations are included.

68. Kartak, F. A. The Case Problem in Engineering Education, 7; 565.

Dean Kartak presents a discussion of the procedure and the results obtained in the use of the case problem method, which aims at the development of an investigatory spirit. Included are descriptions of electrical projects, and of the work in production engineering, management, law, and finance. A summary of the results is presented. In the discussion at the end of the paper, the objections and dangers in the case method as well as its advantages are considered.

69. Lewis, Warren K. The Place of Unit Operations in a Chemical Engineering Curriculum, 7; 596.

Professor Lewis maintains that instruction in unit operations ought not to be used as a means of grounding the student in funda-

mentals, but should develop primarily student initiative and power. The character, value, and limitations of the problem method of instruction are considered. How this method of instruction fits in with instruction in unit operations and with the attainment of the above aim is indicated.

70. O'SHAUGHNESSY, L., AND BERRY, WM. J. Discussion of Professor Edward V. Huntington's Paper on "Teaching the Calculus," 8; 708.

Comments on Professor Huntington's paper are offered. The highpoints, points of disagreement, and criticisms are included.

71. MILLER, J. M. Visual Education Experiments Give Tangible Results, 9; 721.

After a brief review of visual aids, the author describes an experiment on the use of animated motion pictures in descriptive geometry. The results, which were favorable to the film group, are presented along with the results of a questionnaire on student opinion.

72. BABBITT, H. E. Inspection Trips, 9; 778.

This discussion of inspection trips includes consideration of the following points—(1) their justification, (2) when they should be taken, (3) preliminary instruction and advance information, (4) size of party and duration of trip, (5) management and organization, and (6) report or examination. Many practical suggestions are offered.

73. CLEARY, S. F. Correction of Maladjustments to Grounding Courses in Engineering Drawing, 10; 840.

The two chief systems of grounding and a suggested third system are discussed from the administrative point of view. In indicating the advantages of the third or corrected system, the author states ideas that may prove useful to the instructor.

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74. SPAULDING, F. T. Getting Students to Learn, 3; 220.

Professor Spaulding considers the various means of getting students to learn and makes specific recommendations as to the best means of motivating learning. He discusses the compulsion method and points out its disadvantages. Three fundamental conditions essential to the true learning situation are indicated. Emphasizing voluntary learning, he describes three major ways of arousing interest, considering these to be the most effective means of getting students to learn. Finally, various sources of extrinsic interest are presented and discussed.

75. SPAULDING, F. T. Getting Students to Stay Taught, 4; 287.

Professor Spaulding presents and thoroughly considers the three major laws of learning symbolized by the three words readiness, practice, and satisfaction. Rules or suggestions are offered with each, the implications of each are indicated, and means of applying them are illustrated. The curves of learning and forgetting are discussed. In showing how the suggested procedures may be successfully applied, Professor Spaulding indicates three major economies that would save time in much of our present teaching.

76. SPAULDING, F. T. Can the Teacher Justify his Job?, 5; 384.

In the light of various investigations the real contribution of the average teacher is under question. Does the college teacher do more than can be done by individual-study materials? Does the college teacher do more than set tasks for his students, provide them with information, and examine them as to the results of their study? These are the questions with which Professor Spaulding is concerned. Having raised the question, "Can the teacher justify his job?," he proceeds to indicate how teaching could be done so as to justify itself. The characteristics of group learning and the means for making it effective are discussed, for in group learning, especially under guidance, lies the justification of the teacher's job. The problem approach and group discussion are emphasized. In the course of this paper various plans and methods of teaching are described, and a number of specific suggestions for the improvement of teaching are offered.

77. DUNKIN, W. V. The Relative Value of the Teaching of Machine Design with and without the Making of Drawings, 6; 454.

Emphasizes the importance of mastering principles and fundamentals rather than specializing in technical details. Indicates where drawings should be used and where they should be omitted. Recommends spending a minimum of time on "layout" work.

78. HALL, B. R. Method of Treating the Subject of Pattern Design at the University of Illinois, 7; 504.

The procedure in this method, which emphasizes training and material of practical use, is described. Sketching and drawing are substituted for actual manual work to allow more time for studying the design of patterns. The method uses the problem approach and permits adaptation to individual differences.

79. BENNETT, EDWARD. The "Board of Inquiry" versus the "Lecture Recitation" Method of Education, 7; 512.

The "lecture-recitation" method is described and its weak-

nesses indicated. The "board of inquiry" method is then considered with an outline of it and a description of its organization. Emphasis is placed on the spirit of the "hearings."

80. PRICE, L. C. Design and Construction Projects as Activities for Engineering Students, 8; 545.

After a review of the extra-curricular activities open to engineering students, the need for creative work is indicated. The advantages and disadvantages of extra-curricular projects are considered. Several projects are outlined, and the experiences at the University of Arkansas and the results of a survey are presented. In the "Discussion," Professor Carlson adds valuable comments to the conclusions of the author.

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81. CROTHERS, H. M. High School Instruction in Mathematics for Engineering Students, 2; 185.

The author presents his views on the teaching of mathematics. He distinguishes two main questions: (1) How is teaching performed? (manipulative skill); and (2) Why is it done this way? (comprehension and reasoning). He recommends that correlative with advance from arithmetic to algebra there should be a shift of emphasis from the "how?" to the "why?" or from memory to reasoning.

82. HITCHCOCK, E. A. Some Reflections on Engineering Education, 4; 345.

A variety of observations and a number of reflections based on long personal experience are offered. Among these are Dean Hitchcock's views on the value of material of engineering courses, on fairness in instruction, on the efficacy of various teaching methods, on grading and the point system, and on the need for adapting to individual differences.

83. LEUTWILER, O. A. Classroom Methods in Machine Design, 5; 560.

An outline of the classroom methods in machine design is presented under the three heads: (1) Theory; (2) Computations; (3) Machine Layout. Specific suggestions for the instructor relating to student activities and the supervision of instruction are included.

84. MOORE, H. F. Teaching of Materials in Machine Design, 5; 571.

This paper considers the following main topics: (1) The general problem of teaching materials; (2) Source of information concern-

ing materials; (3) Some "general principles" for the study of materials; and (4) Methods of teaching materials. Among the methods considered are the lecture, the textbook and recitation, the laboratory-recitation, and the case method, which is recommended especially for the teaching of general principles.

85. SHOUDY, W. A. The Teaching of English in Engineering Schools, 6; 673.

Recommends that English be taught as a useful tool to the engineer. Suggests, therefore, that it be a course on the art of expression with the emphasis on effective writing and effective speaking. Suggestions for learning to write for the layman, for building up vocabulary, and for developing effective speech are included.

86. KNIGHT, A. R. Engineering Education, 7; 702.

Lists the four important mental qualities needed by the successful engineer as reasoning power, comprehension, memory, and concentration. Methods for developing these mental qualities are suggested. An illustrative problem used in developing reasoning power is presented.

87. EVERITT, W. L. Lecture Room Demonstrations of Certain Phenomena in Communication Engineering, 7; 736.

Presents some of the possibilities in the lecture-room demonstration of those fundamental principles of physics which have important applications in communication engineering. Suggests that an understanding of these general fundamentals would prepare electrical engineers and physicists for service in any field. Discusses models to illustrate transmission line relations, the use of the vacuum tube, and the behavior of networks under impressed voltages consisting of bands of frequencies.

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88. WOODWARD, S. M. Open Questions in the Teaching of Mechanics, 4; 398.

Reports on the variations in opinion among different teachers regarding the chief objectives of the course in mechanics, and the relative importance of that course in the whole school curriculum. Suggests that the minimum essentials of mechanics be learned completely and thoroughly in one course. Proposes, further, that consideration be given to this problem: Shall each course in the engineering school be a unit in itself, or should it be made and understood as a relative part of a unified curriculum?

89. Collected Papers of the Physics Session of the Summer School for Engineering Teachers, July, 1928, 5; 421.

(*a*) FRANKLIN, W. S. Objectives of Undergraduate Courses in Physics for Engineering Students, 5; 421.

States that the all-important objective in the teaching of physics is to train students in analytical thinking. Such thinking must relate to actual physical conditions and things. Precise ideas of theories, and precise definitions are necessarily involved.

(*b*) DUFF, A. W. Physics in Engineering Curricula: A Review of Present Conditions, 5; 426.

Reviews the present condition of physics in the engineering curricula. States that his own research shows considerable variation in the time expended in, and the objectives of, the physics courses in many colleges. Raises, then, these questions: Where does physics belong in the four-year engineering course; and, What are to be the objectives of such a course?

(*c*) DEARBORN, W. F. Laws of Learning, 5; 428.

Maintains that teaching will be effective as teachers learn beforehand those principles that make for efficiency in learning. Gives considerable time to a discussion of the laws of learning.

(*d*) STEWART, O. M. Teaching the Fundamentals of Physics: Mechanics, 5; 448.

Points out a means of improving the present methods of teaching physics. Suggests greater simplicity, a limitation of the subject to the essentials, the use of familiar units, and the proper use of technical terms.

(*e*) DUFF, A. W. Teaching the Fundamentals of Physics: Heat, 5; 451.

Maintains that heat is comparatively easy to teach because of the abundance of familiar illustrations. Thinks that these should be utilized to the utmost, but without going into engineering applications. Offers examples.

(*f*) FRANKLIN, W. S. Teaching the Fundamentals of Physics: Electricity and Magnetism, 5; 454.

Presents his method of teaching electricity and magnetism to students. Follows closely the order of Franklin and MacNutt's "Electricity"—a book that begins with electric-current phenomena, proceeds to the consideration of the condenser, and thence to the general subject of electrostatics. Uses the units of the electromagnetic system and the closely related units of the ohm-ampere-volt system.

(*g*) STEWART, O. M. Teaching the Fundamentals of Physics: Light and Sound, 5; 459.

Says that the teacher has a relatively great freedom of choice in planning his course in light and sound. Urges the necessity of remembering always the aims of the course and the ability of the student. Believes that physical principles, rather than geometric relationships, should dominate the work on light. Presents subject from an experimental and descriptive view-point. Cites examples.

(*h*) DUFF, A. W. The Lecture, Class-Discussion, and Laboratory in Physics Courses, 5; 462.

Discusses the purposes of the three types of class exercises: lecture, class-discussion, and demonstration.

(*i*) ADAMS, SIR JOHN. The Lecture as a Teaching Medium, 5; 464.

Talks on the lecture as a teaching medium. Touches briefly the problem of class note-taking, and the laboratory as a teaching method.

(*j*) DUFF, A. W. The Function of Laboratory Work in Physics Courses, 5; 465.

Considers the function of laboratory work in physics courses. Declares that laboratory work is valuable as a unifier of theory (concepts and principles), and practice (familiarity with methods and instruments).

(*k*) DUFF, A. W. Lecture-Demonstrations in Teaching Physics, 5; 467.

Outlines the desirable qualities that lecture-room experiments should possess.

(*l*) STEWART, O. M., AND DEARBORN, W. F. The Class-Discussion Method in Physics, 5; 471.

Professor Stewart points out the "rules" which may be followed in reference to the class-discussion method in physics. Professor Dearborn maintains that the recitation as a teaching method is seldom successful or pedagogically sound. Goes on to talk of "reviews," "drills," and the proper use of the textbook in a physics course.

(*m*) DEARBORN, W. F. Sectioning on the Basis of Ability, 5; 475.

This paper considers the problem of "sectioning" on the basis of ability. Although there are important criticisms against sectioning, Professor Dearborn regards it, on the whole, as a valuable principle.

(*n*) SEVERINGHAUS, W. L. How May Physics be made of more Vital Interest?, 5; 477.

Describes ways in which physics may be made of more vital interest. We need, the author writes, "to cultivate the interest of the student and along with that interest convince him of the practical importance of what he is doing." This is done by encouraging the student to independent thought, by providing an outlet for his creative tendencies, and by furnishing well-equipped laboratories and exhibition rooms.

(*o*) DEARBORN, W. F. Observations Concerning Teaching Methods Presented at the Summer School, 5; 487.

Comments on the prevailing impression that teaching must take its cue from the learning process. Concludes that methods should be governed by the needs, capacity, and desires of the student.

90. BARKER, J. W., AND FRAZIER, R. H. Educational Processes as Employed in the Department of Electrical Engineering at The Massachusetts Institute of Technology, 7: 619.

After a general introduction on the educational ideals of the electrical engineering department at M. I. T., these two men discuss the educational processes employed. Point out that the course is based on a firm mathematical-physics foundation upon which the processes of introduction, orientation, and liberalization are built and correlated. Remark that a sympathetic interest and stimulation on the part of those who direct the students is supported by much laboratory and honors work.

91. JACKSON, D. C., JR. Electrical Engineering Instruction in the Dynamo Laboratory, 7; 645.

Asserts that the larger end of laboratory work is a thorough understanding of the investigative method. Offers specific recommendations for electrical engineering instruction in the dynamo laboratory. Recommends written reports before and after each experiment. Urges the need of good equipment and infectiously enthusiastic young instructors in the laboratory.

92. LANIER, A. C. The Teaching of Electrical Design, 7; 648.

Believes that electrical design should be taught from the point of view of the value of the instruction to all students of electrical engineering. Suggests that design problems, correlated with the theoretical study of electrical machinery, will serve as an adequate introductory course in electrical design. Offers several alternatives as to method and procedure in the planning of the course.

93. SLICHTER, W. I. Discussion of Electrical Design, 7; 651.

Reports on the activities and aims of a course on the design of electrical machinery at Columbia. Explains that the main object of the course is to teach a knowledge of the various circuits, and to inculcate a thorough understanding of the internal workings of electric machinery. Finds value in assigning to students the computations of machines that actually exist.

94. LANIER, A. C. Comments upon the Discussion of Electrical Design of Professor W. I. Slichter, 7; 653.

Discovers himself in substantial agreement with Professor Slichter. Differences arise in connection with a conflicting belief as to the content and treatment of courses prerequisite to advanced courses in electrical machine theory.

95. ALBERT, A. L. The Preparation of Laboratory Reports, 8; 849.

Requires his electrical engineering students to prepare their laboratory reports in accordance with the requirements of the American Institute of Electrical Engineers for technical papers. Tells of the success of this method at Oregon State College.

96. POORMAN, A. P. A Comparison of Classroom Methods in the Teaching of Mechanics, 9; 891.

After remarking that the true and experienced teacher senses intuitively the proper classroom procedure, Poorman compares, for the benefit of inexperienced teachers, the various pedagogical methods of which they can avail themselves.

97. GILKEY, H. J. Thoughts on Materials Testing, 9; 902.

Comments on the wide diversity of opinion regarding course methods in Materials Testing. Gives an illustrative detailed consideration of a typical laboratory experiment and an allied specification. The author's aim is to lead teachers to scrutinize their course, and the objectives of that course, with a view either to justification or improvement.

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98. HICKERSON, T. F. Discussion: A Suggested Method of Presenting Newton's Second Law of Motion, 5; 511.

Sees no escape from the idea of mass in studying thoroughly the subject of kinetics. Maintains that mass is an integral part of Newton's Second Law of Motion, even if it is not mentioned in the final formula as used by engineers. The universal Law of Motion applying to a given body at any point on the earth's surface becomes, thus, $F = KMa$.

99. COMSTOCK, E. H. Modern Educational Tendencies as Affecting the Preparation of Engineering Students, 7; 737.

Finds pre-college training of engineers lacking in "those elements of definiteness and thoroughness which are so essential in the training of engineers." Asks how much of this lack is due to modern educational tendencies with their emphasis on a superficial acquaintance with many subjects rather than on a fair mastery of a few.

100. DICKINSON, C. A. Psychological Factors Involved in the Presentation of Class Material, 7; 750.

Treats briefly the factors of attention, perception, visual aids, human interest, and the conduct of discussion groups. Believes an intelligent consideration of these psychological factors to be of profound importance in the presentation of class material.

101. CURTIS, D. D. A Study of the Learning Process, 8; 790.

Recounts an experiment at the University of Iowa which attempted accurately to measure the time spent by the individual students upon different units of work included in the subject of statistics.

102. MICHEL, RUDOLPH. On the Teaching of Isometric Drawing, 8; 842.

Gives a short explanation of a new, and to him effective, method of presenting the subject of isometric drawing.

103. MERRIMAN, CURTIS. Standards for Good Teaching, 9: 867.

Discusses teaching procedure and some general Laws of Learning that are important in raising the standards of teaching.

104. MCCARTHY, R. H. Rational Presentation of Flue Gas Analysis Computations, 10; 940.

Believes it desirable to use a computation procedure based directly on fundamentals, each step of which involves no great jump of reasoning, and retains quite a definite physical conception. Cites example.

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105. KIRK, R. E., AND HEISIG, G. B. General Chemistry for Engineering Students, 8; 815.

Presents a statement of what is being attempted in general chemistry at the University of Minnesota. Enumerates the aims and content of the course. Describes the classroom procedure, and their unusual approach to the problem of laboratory work.

106. VANLEER, B. R. Laboratory Instruction in the Department of Mechanical and Electrical Engineering of the University of California, 9; 871.

Professor Vanleer's paper deals with this problem: What system of instruction shall be used in a large engineering school where education, of necessity, is mass education? The thesis proposed is that there are possibilities in laboratory work which can overcome the handicap of the large number of students in the classroom. A plan is presented which has been used to advantage at the University of California.

107. BENNETT, C. RALPH. The Touch System (English), 9; 880.

Writes from his experience of teaching freshman composition to engineering students. Feels that his "touch system" (personal conferences with students) is more interesting and helpful than is "boudoir theme reading" and the writing of comments that do not draw on the understanding that conferences give.

108. WILLIAMS, C. C. Specifications for Procedure in Undergraduate Teaching in the Department of Civil Engineering at the University of ————, 10; 892.

Gives the definition and purpose of undergraduate courses in civil engineering. The aim of the paper is (1) to aid less experienced teachers, and (2) to promote uniformity of practice.

REPORT OF THE INVESTIGATION OF ENGINEERING EDUCATION (1923–1929)

Volume I

109. HAMMOND, H. P., AND STODDARD, G. D. A Study of Placement Examinations (Sectioning of Classes) pp. 707–709; 720–726.

WICKENDEN, W. E. A Comparative Study of Engineering Education in the United States and in Europe.

110. France. Bulletin 16, pp. 833; 843–846.
111. England. Bulletin 16, pp. 900–901; 936–938.
112. Germany. Bulletin 16, pp. 952–953; 960–963.
113. United States. Bulletin 16, pp. 1006–1007.

Volume II

114. WICKENDEN, W. E. Are the Aims and Process of Engineering Education Sound?, pp. 1070–1077.
115. WICKENDEN, W. E. Can Curricula and Teaching Processes Be Made More Effective?, pp. 1090–1102.
116. HAMMOND, H. P. 1930 Survey of Engineering Education—Educational Development, pp. 1196–1212.

SAFE PRACTICES IN COLLEGE LABORATORIES *

By M. S. COOVER

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"Accidents Don't Happen—They Are Committed." Whoever made that statement deserves much credit. The more one thinks of its meaning, the more truth there seems to be in it. Reconstruct any incident of a trivial or of a serious nature that is popularly classed as an accident and ordinarily it will not be difficult to identify those elements, which, if dealt with properly, would have avoided or prevented the accident.

A number of papers have appeared from time to time on the subjects of accidents, danger, and death by electricity, yet it seems that no direct effort has been made to cover the subject of this paper. The increase over the past two decades in the number of engineering students attending colleges and universities is well known, and since nearly all engineering students regardless of their classification are required to pursue certain courses of study in the electrical engineering department with the usual accompanying list of laboratory tests, it means simply that the chances for a mishap may have increased unless due precautions have been exercised.

Source of Information

After the opening of the colleges and universities in the fall of 1938, a letter was addressed to the head of the electrical engineering department at one hundred institutions asking for certain information and their practices relative to safety education as it concerns the laboratory program. The response has been most generous and is appreciated thoroughly. It is hoped that in what follows there may be something of interest and of some value to all concerned.

Opinion varies on the need for promoting safety education with engineering students in college laboratories. This is evident from the following four excerpts of letters received, and which are reproduced herein with the permission of the authors:

"I should like to add that it is my personal opinion that

* Presented at the 47th Annual Meeting, S. P. E. E. (Electrical Engineering), Pennsylvania State College, June 19–23, 1939.

safety practices in electrical engineering laboratories could be overdone."

"I suspect there is too much worry about safety in electrical laboratories. A laboratory is not a production shop, with ignorant laborers. In twenty years of electrical teaching I have encountered no laboratory accidents causing an injury."

"A more or less continuous cautioning develops a 'Safety consciousness in the students and they form the habit of being careful.'"

"I might add that we always have been coöperating with the A. I. E. E. Committee on Safety and with the National Safety Council on the matter of safe practices. We feel that the movement is a very worthy one and should be supported by all engineering colleges."

Fortunately not many accidents occur in college laboratories, and on account of the infrequency of serious accidents therein, it is difficult sometimes to arouse interest in safety education. One thing that should be remembered, however, is that for the most part college graduates sooner or later occupy positions with executive responsibility and therefore may have a direct hand in industrial relations, shop management, etc. If the graduate has a knowledge of applied safety when he leaves college it may be invaluable to him in later life.

One of the most effective methods of impressing students with the importance of accident prevention is to enlist the interest, support, and personal participation of the administrative officers of the colleges and universities. When the laboratory program has been running smoothly for some time it is perfectly easy and humanly natural to relax quite unconsciously and sometimes an awakening is in order.

Safety Instruction

The general plan followed is to distribute a set of laboratory instructions during the first period of each laboratory course. Ordinarily the first set has more to do with the problems of safe conduct than subsequent ones. The nature and scope of the instructions for testing equipment is quite diversified as might be expected, but the elements of accident prevention whenever included follow the generally accepted recommendations. There is an evident wide-spread feeling on the importance of having all new students and all transfer students receive the necessary instruction on safety measures. Procedures to be observed are sometimes given only verbally and at other times they are listed in print. They are or should be reviewed by the instructor in charge. He

should explain the instructions on safe conduct and demonstrate them insofar as may be practical, at the same time emphasizing the hazards, the precautions to be taken, and what to do in the event of trouble.

As much as two or more consecutive periods at the beginning of electrical laboratory courses sometimes are devoted to this work in which attention is directed primarily to safe and efficient conduct. Occasionally instruction on "first aid" and "resuscitation" in case of electric shock is given at the second and third laboratory periods. In a few instances only one direct effort is made to point out safe practices. It is made at the beginning of the first laboratory performance period as scheduled in the curriculum and then only seemingly an occasional mention is made thereafter, while in still other instances it is reported that safety instructions are repeated from time to time even well into the senior year according as the instructor may deem it advisable.

Some exceptions to what appears to be the general practice may be of especial interest. Several schools report the distribution of a set of fairly complete instructions which are followed in due time by special attention being directed to safe practices for the particular laboratory, viz., circuits, dynamo machinery, transformer, lighting, communication, high voltage, etc.

One institution reports that, "We have no preliminary instructions for laboratory experiments or for safety practices, because we feel that the students learn better and more quickly by *doing* the work than by listening to a talk or lecture. The student wires up an experiment in his first period in the laboratory and when the wiring has been inspected and approved by the instructor and the power is turned on up to the student's main switch, the instructor shows the student how to close a knife switch in a safe manner, pointing out that there is no half-way closing of a switch—that it is either open or closed—and the danger to the operator of having too small an area of contact for the current that must be carried. The danger of short-circuits as contrasted with high voltage is also pointed out. The danger of opening the field circuit of a shunt motor is likewise pointed out in the first experiment."

Another states that, "As we have no prepared material along the line of safety practice in our laboratory I shall confine my reply according to the outline in your letter.

"At the first meeting of laboratory classes test table diagrams are given the students and special stress is laid upon safety in making connections and handling machinery. No students are permitted to conduct tests of any sort unless an available instructor is in the building for supervision."

Still another states, "We give brief but definite instructions on safety and emphasize the fact that no circuits are to be energized until the connections have been checked by the instructor in charge."

In contrast to these, another comments that, "We give preliminary instructions on the proper methods of connecting up the switchboards and the circuit wiring and add to this from time to time. Students will not remember a lengthy list of safety rules if given to them all at once."

An outline of the findings on this topic could not be considered complete without citing an apparently new procedure and the only one of its kind submitted so far. It is reported as follows: "The correct location of circuit breaker, the order of the connections in making a circuit, and the correct procedure in dismantling a circuit are demonstrated.

"The Department of Photography is now coöperating in the production of motion pictures demonstrating correct methods of procedure and safe practices in the machinery laboratory. A motion picture illustrating a typical direct-current machinery test is now near completion. The incomplete film was shown to students during the summer quarter with encouraging results.

"A few questions regarding safe practices must be answered by the student in his first report."

While it is true that certain instruction on safe procedures is given in some form to all students the first time they undertake a laboratory course, it is believed that the outline of precautions to be found in Appendix A of this paper might well be adopted wherever they are not now in use. A copy could be made available to each student at small cost.

Direct Coupling vs. Belt Drive

The predominant methods of connecting electrical machines in the laboratory is either by some form of direct coupling or by belts. Only a few exceptions were reported. In one laboratory, two Texrope drives are used but no statement was included with respect to guards. One chain drive is used at each of two institutions, the one chain being provided with a guard and the other is without a guard. In another laboratory, one gear drive with guard may be found.

At present there is about an equal division in the use of the two predominating types of drive. It is found that where direct connection is employed, both the rigid and flexible couplings are used, but preference is given to the flexible type on account of its many advantages and the desirable interchangeability of machines where

this practice is followed. There are probably as many different physical arrangements as there are laboratories. Buildings differ in plan, wiring for power circuits hardly would be duplicated, and provision for connecting electrical equipment to the power supply will vary, all of which points to the need of exercising care in how the equipment is used.

Believing that a few comments in the interest of safety regarding the use of different types of drives might be both informative and instructive, the following statements are cited as being fairly representative:

"We use for the most part, belt drives as it seems the only financially feasible system to get the desired flexibility. We have no guards other than test tables which are often placed so as to act somewhat as guards."

"Belt guards are not provided. However, students are not allowed to work on the belt side of a machine."

"While most of our testing in this laboratory is done with belted machines in order to give greater flexibility of equipment, we do have a number of direct connected coupled types. We do not use belt guards, but are considering the design of some type of belt guard. All of the machines that are direct coupled have flexible couplings, and both machines are on a common base. We do not use guards for the couplings because it is impossible for a man to get up next to it while standing on the floor. The surface of the coupling is fairly smooth, there being no projections to catch a trouser leg or a stray piece of wire."

"We have special guards for use with the couplings when machines are uncoupled. When coupled together there are no protruding or projecting points on the couplings."

"Guards are used wherever couplings are of a type that could catch the clothing of students or otherwise injure them."

"Because of financial limitations most of the experimental sets are belt driven. We prefer direct connection in most cases, but so far have not been able to achieve that end. Preference is for flexible couplings."

"We do not have belt guards, which is a bad point, we admit. Students are warned about getting too close to belts or stepping over belts either moving or stationary. We have been lucky so far."

"No guards are used over any of the couplings or belts, nor over extended rotating shafts with keyways in them."

There is no intention to include in this paper the possible merits of various arrangements of laboratory equipment, or of methods

of teaching laboratory courses. A different grouping of pertinent factors such as already have been mentioned in addition to the curricula, teaching loads, finances, etc., will be found to have a controlling influence at each institution on physical plant and procedure. The chief concern here is that a high degree of integrity be maintained on safe operation regardless of local arrangements.

Recommendations:

(*a*) Keys should be inserted well into the keyways so that they do not protrude beyond the surface of the pulley.

(*b*) Where belts are used, the student should be cautioned on the danger of bending over machines with loose neckties or shirt sleeves.

(*c*) Certain types of rigid and flexible couplings have projections or sharp edges that are real hazards. In such instances they should be protected by guards or the motor-generator set placed in an inaccessible position under an especially designed table with the leads brought up to terminal blocks.

(*d*) If belt drives must be used and special guards are not constructed it would be advisable to place the test tables so that they can act somewhat as guards.

Prony Brake vs. Electro-dynamometer

Both the prony brake and the electro-dynamometer are in general use for loading tests. As might be expected, practice in their use also is quite varied, and the reasons governing their applications are equally diversified. The actual usage of both methods seems to be about equally divided among the institutions.

In response to an inquiry on which method would be adopted in the event of building and equipping a new laboratory, the stated preference was about thirty-seven per cent for the prony brake only, twenty-three per cent for the electro-dynamometer only, and forty per cent for both. For the most part the prony brake is used only on small machines seldom with a rating of over five horsepower. In the interest of safe practices it was found that some make use of the prony brake for static torque tests only. In contrast, others have adopted the brake exclusively and state that no particular precautions are taken in their use.

Recommendations:

(*a*) Chances for physical injury can be reduced to a minimum if prony brakes are constructed to permit only a small amount of motion, and so that reversal of rotation cannot cause injury. This may be done by pipe guards, limit chains, etc. Even a ninety-degree rotation of the arm is to be considered dangerous and should be avoided.

(*b*) Where the prony brake is used, precautions should be taken to start the machine always with the brake band loose until it is seen that the direction of rotation is correct.

(*c*) If a prony brake is used on large machines such as railway motors it should be of very rigid construction and protected with a heavy pipe frame to guard against reverse rotation.

High Voltage

High voltage in the electrical circuits laboratory and in the electrical machinery laboratory for undergraduates is regarded as any value in excess of 125 volts. A number of schools feel that it is important for the senior year students to have one or more tests on the standard type of 2300-volt distribution transformer, but realize that during such tests the students must be given special instruction and that they must be closely supervised throughout the tests. The policy at other schools is to avoid all voltages above 220 to 250 volts for undergraduate tests and to leave the training in the use of higher voltages with the accompanying responsibilities and risks to be taken over by the future employer.

Some radio laboratories have circuit outlets for voltages of 1000 to 2000 volts d.c. Various special types of terminals are used and including a color scheme to serve as an added reminder that those circuits are not of the ordinary laboratory type, but that they are carrying dangerously high voltages. Direct current circuits of even higher voltages than 2000 are frequently used in certain specialized laboratories which makes for appropriate precautions always to be in order.

Unfortunately, the substation that supplies the power for electrical engineering laboratories is not always located in the most desirable place nor does its construction always conform to what is considered to be good engineering practice. Wherever improvements can be made it would be a credit to the institution to do so.

At those few institutions where "High-Voltage" laboratories are operated, they are considered as places of extra hazard and the customary safety precautions are practiced. The hazards are too great to think of conducting tests without suitable interlocks and signals either visible or audible, but preferably both.

Recommendations:

(*a*) All circuits and terminals should be appropriately identified, and guarded.

(*b*) Wherever it is not regarded feasible to build permanent protection around 2300-volt or other high voltage experimental tests, the equipment should be isolated and surrounded with white tape or barricaded so that accidental contact with any part of the

equipment is practically impossible. Furthermore, an adequate number of warning signs should be exhibited.

(*c*) It is desirable to have all high-voltage experimentation conducted in a room or a building separated from the undergraduate electrical machinery laboratory.

(*d*) It must be recognized that transient voltages may be generated in apparatus of low voltage rating. A particularly dangerous set-up requiring special care is one that involves series or parallel resonant circuits.

(*e*) Instructors should always be present in the laboratories when the laboratory is in operation.

(*f*) All framework, machine bases, etc., subject to dangerous potentials should be solidly grounded. On this matter it is advisable to follow the National Electric Code.

(*g*) All circuits connected to the substation buses and terminating on laboratory switchboards should be equipped with pilot lights or the brass receptacles should be painted red. In general, all live circuits should be indicated with pilot lights.

Switchboards

The switchboard or transfer panels in each laboratory from which power is distributed to the several test stations can be a source of some danger. The almost universal method of energizing the laboratory distribution circuits is by means of flexible jumpers plugged into receptacles on the panels. It will be found more often than not that these boards are handled upon the basis that all circuits are live circuits. This reasoning, it is argued by many, would exclude the necessity of using pilot lights to indicate live circuits.

On the other hand, the front of the switchboard offers more chance for accidents than does the back of the board. Pilot lights are inexpensive and easy to install. If they are connected across the terminals of the power feeders terminating on the laboratory distribution boards, they serve as an ever present silent reminder that caution should be exercised. For this reason alone, it is believed that the cost of installation and maintenance of pilot lights to indicate live circuits can be justified.

One modification of the general plan of operating the electrical machinery laboratory that was reported is to have the test tables fixed in place and provision for moving any machine to the test table on a lift truck. All machines are on life-truck platforms ready for transfer to any location. Where this system is used, power from the main distribution panel is switched to the test tables on permanent circuits, with pilot lights on the test tables.

One comment that was submitted concerning switchboards merits reproduction:

> "We are particularly careful with regard to enclosing the ends of our switchboards, keeping the rear of the switchboard as neat and clean as the front, eliminating any loose material which might trip those who go to the back of the switchboard and put exceptionally good lighting back of the switchboard so that all dangerous parts might be observed."

Recommendations:

(*a*) Switchboards should be screened off at both ends to prevent unauthorized persons from going behind them. Obstruction of the passageway with portable equipment is not a guarantee of safety.

(*b*) Plug receptacles should be inspected with a frequency consistent with their usage and kept in good repair.

(*c*) The merits of pilot lights to indicate live circuits should be given serious consideration.

(*d*) Good lighting behind the switchboard is as essential as in front.

Fire Extinguishers

It hardly seems necessary to emphasize the importance of adequate fire fighting equipment. On the other hand, it is not uncommon to find in some laboratories the need of both fire hose and hand-operated extinguishers. The apparatus should be located conspicuously and in the case of extinguishers care should be taken that they are of a type that is safe to use on live high voltage circuits. Periodic checks should be made on all extinguishers to see that they are filled and in working order.

In some states the insurance underwriters require that certain types of extinguishers are to be used. Ordinarily the service department of the college or university is required to install fire-fighting equipment to comply with certain ordinances or regulations and periodically to check their condition.

First Aids

At many institutions the campus hospital is within easy reach and its medical services are available at all hours of the day. The feeling seems to be quite general that with such local conveniences coupled with the fact that a majority of students have received extensive instruction in first aid through various organizations such as the Red Cross, Boy Scouts, etc., the men will report promptly and voluntarily for treatment, even in the case of minor cuts and bruises.

Recommendations:

(*a*) Wherever convenient medical facilities are not available, first aid supplies should be kept in the central meter room.

(*b*) Physicians' names and telephone numbers should be posted near to or preferably within the frame containing the resuscitation chart.

(*c*) Resuscitation charts should be posted in every laboratory.

(*d*) Even though most of the students are already familiar with acceptable first aid practices and resuscitation methods, they should be tested or examined from time to time on their ability to perform resuscitation methods satisfactorily.

(*e*) Every instructor should be well versed on resuscitation methods. At least one instructor should be in the laboratory while students are pursuing their work.

(*f*) A departmental or divisional committee on safety is advocated to make an annual inspection and report to appropriate college administrative officers.

(*g*) There is a wide diversity of opinion of the proper medical treatment in the case of accidents. The local medical department should be consulted on this matter so that first aid methods may more nearly conform to the efforts of the physician when he takes charge.

Instructions for Resuscitation

Instructions for resuscitation from electrical shock by the prone pressure method are available for the asking. They should be placed in the hands of every student taking laboratory courses and preferably printed and bound within his manual on laboratory notes and instructions. It is remommended that safety demonstrations be given and repeated often enough to insure that the student has learned how to use them effectively.

Conclusions

A reproduction of the many comments contained in the correspondence received relative to the efforts of the Committee on Safety with respect to college laboratories would be convincing evidence that the present movement is worthwhile. Space prohibits reproducing all of them, but a fair sample of those comments is,

> "I am glad that you are getting this material together because I believe that some of us can profit considerably from the information once it has been collated."

It is difficult sometimes to arouse the proper interest in a safety program for the college laboratory on account of the infrequency

of serious accidents. For this reason, if for no other, some special effort should be made each year by the appropriate college officers to develop within the teacher and the student a safety consciousness which will help to protect them against accidents.

One of the most effective ways to teach accident prevention is to formulate a definite safety program and follow it. Wherever possible a first-aid team should be brought to the campus from an industrial organization, a fire department or a police department for the purpose of demonstration. Instructions on resuscitation should be in the hands of every student doing laboratory work, and periodic checks on his understanding knowledge of them very properly could be made a part of the instruction in the course. Every encouragement should be given to any workable system that will fit into the engineering curriculum and that will assist in eliminating unsafe conditions and practices.

APPENDIX A

Laboratory Instructions on Safety Rules

Never hurry. Haste causes many accidents.

Connect to the source of power last.

Disconnect the source of power first.

Burns from the arcs may be very severe.

Always assume that circuit sources are alive. Remember that any laboratory circuit may be energized at any time.

Work deliberately and carefully as you proceed. Verify your connections and be sure that they have been made secure.

Avoid placing any part of your body in circuit, either to ground or across terminals.

Never close a circuit until individuals are clear of mechanical equipment and circuit breakers.

Keep the face away from circuit breakers.

Avoid the possibility of exposing your eyes to electric arcs, for they are powerful generators of ultra-violet light, including wave lengths that may cause serious and painful injury to the eyes, even with very short exposures.

Close and open circuits with suitable apparatus.

Never close a switch slowly or hesitatingly.

Check the supply circuit voltage to see that it is what you expect —either a.c. or d.c.—before closing circuits.

Avoid running wires over or under a belt.

Never step over a belt while it is in motion. It may break or run off at any time.

KEEP WATCH CHAINS, finger rings, wrist watches, metallic pencils, metal-bound measuring rules, etc., OUT OF CONTACT WITH LIVE PARTS when working around electrical apparatus.

KEEP NECKTIES and loose clothing AWAY FROM moving BELTS or rotating parts of machinery.

USE EXTREME CARE WHEN BREAKING AN INDUCTIVE CIRCUIT.

DO NOT LIFT BRUSHES from a commutator or slip ring while machines are in operation.

DO NOT USE VOLTMETERS UNTIL the ends of the two LEADS are FASTENED FIRMLY to suitable posts ON THE INSTRUMENT.

DO NOT, UNDER ANY CIRCUMSTANCES, open the secondary of a current transformer while it is carrying current.

APPENDIX B

DISCUSSION

Among the pertinent points brought out in discussion on this paper following the presentation of it at the 1939 annual convention of the Society were that:

The laboratory equipment always should be maintained in first class condition.

The equipment always should present a good appearance.

It is important that the wiring in the laboratory is neat and safe.

The student should be informed properly and made to feel the importance of the laboratory tests.

Every student in the squad should be made to feel equal responsibility for the test performance and the obligation to share equally on damage to instruments and equipment.

Accidents are more often than not, the result of two or more associated circumstances. Seldom does a single thing cause an accident.

Usually only one or two staff members are safety conscious and the others are not.

Every engineering faculty should maintain a safety team composed of representation from each department. This team very properly could be made the standing committee on safety.

Too much emphasis cannot be laid on the hazards of runaway shunt motors.

All too often there appears to be some question as to who is to be made safe, the instructor or the student.

Fire extinguishers should not be placed too close to where trouble is likely to develop.

A DAY WITH EUCLID

By ROBINS FLEMING

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The engineer wearied with problems in his line of work may find change and refreshment in spending a day with Euclid. The "Day" will be devoted to Proposition 47, Book I, of "The Elements of Euclid." A standard text (Robert Stimson) states this well-known proposition: "In any right-angled triangle, the square which is described on the side subtending the right angle is equal to the squares described on the sides which contain the right angle." Dr. Eric T. Bell in his "Men of Mathematics," 1937 (p. 398), refers to it as "the Pythagorean proposition that the square on the longest side of a right triangle is equal to the sum of the squares on the other two sides."

A great many proofs * have been given of this proposition. The writer in his early days collected fourteen, one of which was credited to General James A. Garfield. They were later published in *The Journal of Education* June 23 and July 30, 1887. In *The Mathematical Monthly,* a brilliant but short-lived periodical, 28 proofs were given in the issue of November 1859. Camerer in his Latin and Greek edition of Euclid (copy at hand dated 1824) gives 17 proofs. *The American Mathematical Monthly,* Volumes III, IV, V and VI, 1896–1899, in a series of articles by B. F. Yanney and J. A. Calderhead, present no less than 100 demonstrations, some of which however are but modifications of other demonstrations. This is the case with a number of proofs found in collections. Dr. Todhunter in his "Notes" on the Euclid of "Everyman's Library" gives what he calls "one of the most interesting" and mentions a collection by J. J. I. Hoffman, Mainz, 1921.

Dr. Lancelot Hogben in his "Mathematics for the Million," 1937 (p. 63), gives a curious proof from a Chinese book, "probably written about A.D. 40." In this notable book (p. 67) Dr. Hogben says that the Egyptian method of laying out a right angle is still in use. He quotes from Bulletin Number 2 of the Ministry of Agriculture and Fisheries (1935):

> The easiest method of chaining a right angle is as follows: The 24th link is pegged at the point from which the angle is to be set out, the nought

* "Engineer's Mathematical Recreations," Robins Fleming. *The Canadian Engineer,* Vol. 47, p. 465, December 30, 1924.

end of the chain and the 96th link are pegged together, back along the base line, so that the piece of chain 0–24 is taut. If the 56th link is taken in the direction required until both the sections 24–56 and 56–96 are taut, then the point reached will be at right angles to the base.

It is readily seen that the sides 24, 32 and 40 links of the triangle thus formed are the same multiple of 3, 4 and 5. Teachers often wish to express the sides of right-angled triangles in whole numbers. To do this nearly all the boys in an arithmetic class added one-half the length of the longer leg to the shorter leg. Of course, their answers were only correct when the ratio of the longer leg to be shorter leg was 4: 3.

By giving values of $(a^2 - b^2)$ and $(2\ ab)$ to the legs of a right-angled triangle the hypothenuse will be $(a^2 + b^2)$ because $(a^2 - b^2)^2 + (2\ a\ b)^2 = (a^2 + b^2)^2$. For all values of a and b, provided they are whole numbers and unequal, the three sides of the triangle will be whole numbers. Substituting in the formula values of 1, 2, 3, 4, 5, 6, respectively, for b and greater values for a, 30 triangles may be found, all sides of which are less than 100. Multiples of the sides thus found will add, not including duplicates, 20 to the number, making 50 right-angled triangles, the three sides of which are whole numbers less than 100. If the triangles 60, 80, 100 and 28, 96, 100 are added we have 52 right-angled triangles, no side of any exceeding 100. This agrees with the number found by Professor D. W. Hoyt, "Right-Angled Triangles with Commensurable Sides," *The Mathematical Monthly,* Vol. II, p. 264, May 1860. In the same volume of this periodical, p. 336, July 1860, Professor E. S. Snell, "Note on Right-Angled Triangles," also gives 52 as the number of right-angled triangles, no sides of any exceeding 100. He writes, "I prepared the series by using the formula $(a^2 + b^2)^2 = (a^2 - b^2)^2 + (2\ a\ b)^2$." He adds, "I cannot now call to mind where I found the formula."

CONTENT OF THE MECHANICAL ENGINEERING CURRICULUM *

By RALPH E. FLANDERS

President, Jones & Lamson Machine Co., Springfield, Vt.

Perhaps it is not possible to give definite recommendations as to the content of the mechanical engineering curriculum owing to the fact that a considerable variety of types exists among practicing engineers. I believe, in fact, that at least three types of engineering education are necessary to meet the variation in training needed for different existing conditions.

For the sake of discussion, we may divide engineers into seven different functions. Some individual engineers may confine themselves quite narrowly to one function; other individuals will find their daily work including two or three, or even more, functions, or even perhaps in extreme cases, all of them. A suggested tabulation of functions would be:

1. Maintenance.
2. Operating and processing.
3. Production methods.
4. Executive functions.
5. Designing.
6. Consulting.
7. Research.

It will be noted that these functions are not given in the order of the monetary rewards involved, since in this case the executive function would head the list. The order roughly gives in ascending degree the rigor of engineering training required.

The first three functions may be said to constitute the group of *Technicians* in which perhaps a less rigorous preparation is permissible and a broader study of details is more desirable than in the case of the other types of functions. In this group it is essential that the student shall have a thorough knowledge of the mechanisms and processes in the broad field of mechanical engineering, that he shall have a fair grounding in fundamentals, and that he shall know where to go for information (whether in text books, reference books, or current literature) on subjects with which he

* Presented at a meeting of the New England Section, S. P. E. E., at Northeastern University, October 14, 1939.

is concerned. To put it in the roughest terms, this group should be trained to be really first-class "hand-book engineers."

The fourth group, that of executives, is in a class by itself. Many engineering schools recognize this by setting up industrial engineering courses aimed especially at the training of the manager. It would be interesting to know how many of the executives who have come to the top through the engineering route had specialized training in management in their student courses—and how many of them took a purely engineering training. There is no question as to the large percentage of successful executives who had engineering training. I presume that the figures may be available to show what kind of training they had, but on this subject I am not informed.

If it were possible to discover in advance which students in an engineering course were to become executives, it would be desirable to give those particular students a somewhat broader training, particularly in economics and English.

The designers, the consulting engineers, and the research men all require the most rigorous training in fundamentals, and it is highly doubtful whether elaborate courses on the details of present practice are anywhere nearly so valuable as this thorough grounding. The "present practice" of the schools is almost invariably behind the developing present practice in the field, and the area that would have to be covered in a study of present practice would be so great, not knowing the field into which the graduate was going, that it would be impossible to save time for the fundamentals. The fundamentals are the essentials.

But here, as well as in the training of the candidate for an executive position, a broadened training in such things as economics and English should be added to the deep and thorough training in fundamentals.

This question of English seems to me to be particularly important. The number of engineering graduates, or indeed the number of college graduates in general who do not spell correctly, or do not write with proper grammatical construction, is astonishingly large. These men are handicapped from the start when they get out in life. One suggestion I might make is that engineering written work be graded separately for technical content and for English; and that the grading for English be done by English teachers, rather than by the technical teachers. There are, of course, difficulties in this policy, but something of this sort should be worked out.

The above discussion leads to the suggestion of three types of curricula, all three of which it might not be feasible to carry on in

the same school. This in turn leads to the notion of schools for technicians, schools for industrial executives, and schools for engineers in the strictest sense.

One or two points may be worth bringing up. The first has already been touched on in connection with the question of trying to follow up "present practice" in schools. A most important element in education is summer vacation work in some engineering line allied to the course the student is taking and to the particular interests in engineering which he is following. Unfortunately, there are many years in the course of a business cycle in which it is very difficult to get employment of this sort. Every effort should be made by the student to obtain it.

But there is another reason for emphasizing summer work or a year of work between high school and college. Without such work, the student comes into industry completely unadjusted to industrial life. He does not know what it means to work for a living. The jobs he may be given as a part of his post-graduate industrial training are too often approached as though they constituted a laboratory exercise instead of being a part of a day's work of the world. Furthermore, the student's relations with his fellow-workmen and with his superiors are almost certain to be such as will handicap him until he makes new and more realistic adjustments.

All of these difficulties will be minimized if the boy can get a real job as early in life as possible. He should endeavor to get as well adjusted to work as the boy who has had to work for a living since he arrived at the legal age for leaving school.

The question raised when I was assigned this topic is not answered in this document, but I hope that you will find that question at least opened for discussion.

CIVIL ENGINEERING PAGE

Notes of interest for members of the Civil Engineering Division—Editor, EDWARD E. BAUER, *University of Illinois, Urbana, Illinois*

M. W. FURR, *Chairman*
F. T. MAVIS, *Past Chairman*
PAUL P. RICE, *Secretary*
EDWARD E. BAUER, *Editor*
L. G. STRAUB
F. W. STUBBS, JR.
H. T. HEALD

THE SECOND NATIONAL SURVEYING TEACHERS' CONFERENCE

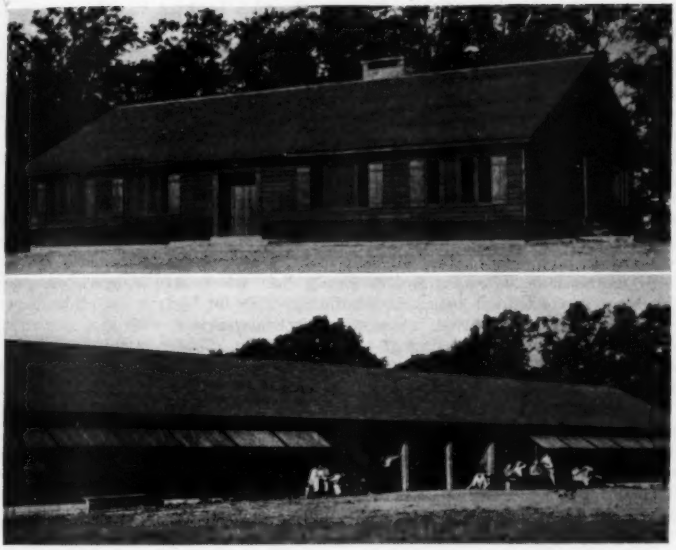
BY MALCOLM S. DOUGLAS

Case School of Applied Science

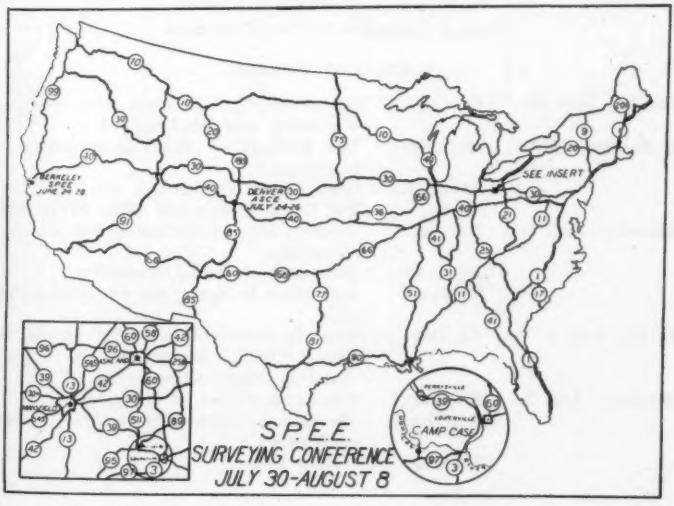
The Second National Surveying Teachers' Conference, sponsored by Committee 8, Surveying and Geodesy, of the Civil Engineering Division of S. P. E. E., will be held July 30 to August 8, 1940, at Camp Case of the Case School of Applied Science. The special committee in charge of this conference consists of: J. S. Dodds, Iowa State College, Chairman; M. S. Douglas, Case School of Applied Science; G. H. Harding, University of Louisville; C. O. Roth, Jr., Cooper Union; H. O. Sharp, Rensselaer Polytechnic Institute; and D. S. Trowbridge, New York University. Each member of the committee is acting as chairman of a sub-committee planning various phases of the program and conference.

The First National Surveying Teachers' Conference was held at the Iowa State College camp in Minnesota during the summer of 1937 as somewhat of an experiment. It aroused so much interest and enthusiasm that it was followed by Regional Conferences at Troy, N. Y.; Louisville, Ky.; Rolla, Mo.; and Atlanta, Ga. Since 1937, there have been many developments in the science of surveying as well as in the technique of presenting the subjects to surveying classes. The results of a questionnaire circulated by the committee in 1939, indicate that there is a desire on the part of surveying teachers for a symposium on teaching Photogrammetry as well as papers and discussions on the use of models and other visual aids, geodesy, practical astronomy, legal phases of surveying, and an analysis of new surveying instruments and materials. The program has been arranged to meet these requests as far as possible and every effort has been made to obtain the outstanding authorities in the various fields to take part in the sessions. At the same time, ample opportunity will be given members to meet informally and become well acquainted.

The formal papers will be presented during the morning sessions with the afternoons devoted to round table discussions or recreation. During the evening sessions, there will be informal discussions and special features. A program of entertainment is being arranged for the ladies attending the conference while the recreational program for the children will be under the direction of an experienced camp counsellor.



VIEWS AT CAMP CASE, MOHICAN STATE PARK, NEAR LOUDONVILLE, OHIO, WHERE THE SECOND NATIONAL SURVEYING CONFERENCE IS TO BE HELD, JULY 30–AUGUST 8, 1940. Upper view: The Lodge; lower view: The Dining Hall.



Camp Case is in the Mohican State Park which is about 85 miles southwest of Cleveland, Ohio, and three miles southwest of Loudonville, Ohio. It is accessible by railroad or highways and arrangements have been made with the Pennsylvania R.R. to have all through trains stop at Loudonville during the conference. Route U. S. 30 is the nearest East-West highway while Loudonville is on Ohio Route 3. The Mohican State Park is a forested area of some 2,000 acres through which runs a 300 foot gorge cut by the Clear Fork of the Mohican River, a lake formed by the recently constructed Pleasant Hill Dam, one of Ohio's flood control projects, adjoins the park area.

The Case School of Applied Science has maintained a camp for summer surveying since 1909. The present camp in the Mohican State Forest, was constructed in 1938 and was designed to accommodate 200 students and the required faculty. The camp buildings consist of a large lodge used for lectures, recreation, and dancing; a dining hall which will accommodate 250 people; a semi-fireproof instrument building, 25 × 50 feet; a six room dispensary; and 10 faculty cabins. A modern kitchen equipped with gas, electricity, and refrigeration is in a wing of the dining hall. Water is supplied from a well 300 feet deep. The camp has a sanitary system, warm showers, and is lighted by electricity.

Arrangements can be made to house at least 80 people in the cabins and other buildings before it will be necessary to resort to the use of the tents that ordinarily are used by students. Registration fee for the camp has been set at $21.00 with a reduction of $2.00 for those who are required to be quartered in tents. For further information, address Professor M. S. Douglas, Case School of Applied Science, University Circle, Cleveland, Ohio.

SECOND NATIONAL SURVEYING TEACHERS' CONFERENCE JULY 30–AUGUST 8, 1940, CAMP CASE, MOHICAN FOREST PARK, OHIO

PROFESSOR J. S. DODDS, *Chairman,*
General Committee on 1940 Conference

PRELIMINARY PROGRAM

Tuesday, July 30	Evening:	Conference officially opens with Dinner—Welcoming and introductions.
Wednesday, July 31	Morning:	The Methods of Teaching Surveying to Engineers.
	Afternoon:	Reserved for Conferences and Recreation.
	Evening:	The Use of Models and Other Visual Aids.
Thursday, Aug. 1	Morning:	Geodesy, Plane Coördinates, and Practical Astronomy.
	Afternoon:	Recreation—informal discussions.
	Evening:	Astronomy in Surveying, by noted astronomer.
Friday, Aug. 2	All Day:	Tour to Cleveland, Ohio, to inspect the Precise Control Survey now in Progress, including Night Observations.
Saturday, Aug. 3	Morning:	The Legal Phases of Surveying.
	Afternoon:	Recreations—competitive sports—informal conferences.
	Evening:	"Barn Dance."

Sunday, Aug. 4		Devotions.
Monday, Aug. 5	Morning and Afternoon:	General Analysis of Surveying Instruments—Materials, Telescopes, Graduations, Centers, etc.
	Evening:	Camp Fire—Tall Stories, Hobbies, etc.
Tuesday, Aug. 6	Morning:	The "ABC's" of Photogrammetry for Undergraduates.
	Afternoon:	Instruction by Teachers of Photogrammetry to Small Groups in the Solution to Typical Problems.
	Evening:	Informal discussions.
Wednesday, Aug. 7	Morning:	Photogrammetry continued—Summary.
	Afternoon:	Business Meeting—Committee Reports.
	Evening:	Entertainment by camp talent.
Thursday, Aug. 8	Morning:	Farewell Breakfast—Adjourn.

Note: In general, the formal papers will be presented during the morning sessions. The afternoons may be devoted entirely to recreation or part of the time may be used for small groups to gather for discussion of special interests. Informal discussions and special presentations will take place during the evening sessions.

ENGINEERING ECONOMY NOTES

Engineering economy is that phase of engineering which pertains to the specifically advantageous use of dollars and cents in engineering works.

EDMUND D. AYRES, The University of Wisconsin, *Editor*

HAVE WE TOO MUCH COMPLACENCY?

Are the teachers of engineering economy a bit too complacent? When we gather together it is seldom that we fail to criticize, at least among ourselves, the flagrant violations of the principles of engineering economy in engineering practice evidenced by published articles and reports. But how often do we swing the searchlight of criticism around to focus upon ourselves? The privilege of editing this page provides both directly and indirectly a broad view of what is being done in the teaching of engineering economy. The insight gained from this view at present is disturbing. It reveals a lack of agreement among engineering economy teachers that possibly reaches basic ideas and suggests a chaotic divergence of opinion concerning much of the detail garnishing these basic ideas.

The dissatisfaction which motivates this expression is not based upon the thought of a general indictment of what we are doing now in teaching. As teachers we now have a decidedly sufficient basis to press our claims vigorously and without apology for a greater recognition of engineering economy as one of the most fundamental of the fundamentals of engineering in both education and practice. Our house is in order but we should not be too complacent about it for there is plenty of evidence that our lawn and fences need attention. Neglect of basic disagreements and diverging attitudes on details among ourselves is certain sooner or later to harm our cases for claims to a more important place in the sun. The family that moves into a new house before the lawn and fences are put in order receives a few months' grace from criticism by the neighbors, but let neglect over a period of time become conspicuous and the occupants of the new house will not be spared the severest kind of comment. Engineering economy can rightfully be considered as having emerged as a body of definite principles, the new house has been built; our disagreements and lack of authority upon many matters, however, are going to look sometime

to our colleagues outside of the engineering economy circle as neglect of duty to band together and thresh out these matters to a finish, just as the family with a new house and a muddy lawn and no shrubs will be undoubtedly criticized, if such a condition persists. While continuing our bid for greater recognition, let us look to this challenge to do something about strengthening the service we offer as rapidly as sound group and individual action will permit.

To overpower the apparent complacency which exists, vigorous group action seems essential. The fact that engineering economy is associated with so many other matters and departments in finding its outlet in engineering education, reduces its command of attention from many whose fields are predominantly in other areas of education; this is so true that engineering economy will face always the need for the unswerving attention of her real devotees. It is time for all of us predominantly interested in the field to pull together—when we do, it can be predicted that many others, whose interest can never attain "first string" quality, will join in to increase the benefits from such action. It would seem wise to attack methodically every area of engineering economy in which disagreements may be found and proceed to settle these matters definitely, one by one, until a body of decisions representing the best thought is available for both use and future study for weakness. Organized activity between interested men in adjacent schools should be planned to carry on such work throughout the year and every opportunity to hold regional and national meetings of those definitely devoted to this work in connection with conventions of an engineering character should be seized upon—these are suggested as ways of implementing group action.

Editorship of these pages perhaps should be passed around, if it were only to help the individual teacher see more clearly the needs of this work of engineering economy on a greater scale than his individual teaching efforts may afford. Your editor is thoroughly aroused to the need for closer coöperation between teachers. Beyond that the need must be met for an earnest and continued research into source material and into the demands of engineering, accounting and legal practice until each principle is bulwarked over its entire range of application with basic economic thought as a foundation and clear cut reasons for the choice of one method of application over another.

ENGLISH NOTES

DEVOTED TO THE INTERESTS OF TEACHERS
OF ENGLISH IN ENGINEERING SCHOOLS

J. L. VAUGHAN, *Editor*, University of Virginia

THE DEPARTMENT OF HUMANITIES AT COOPER UNION

By WILLIAM S. LYNCH

Associate Professor in Charge of Humanities, Cooper Union

Progressive schools of engineering have been concerned for some time with the tendency of engineering education to become more and more specialized in terms of technical training. Like many other educators, the administration and faculty of Cooper Union Schools of Engineering feel that the complexities of modern society and industry demand of graduates of engineering schools a broad human outlook and qualities of personality that will enable them as members of the engineering profession to achieve and exercise the leadership which should be theirs.

In an effort, therefore, to broaden the training of its undergraduates Cooper Union has initiated a Department of Humanities this year. The manner in which this Department is approaching its problems may be of some interest to other institutions which are working in similar directions.

It goes without saying that the newly formed Department of Humanities believes most firmly in the philosophy of education which aims to awaken cultural and social responsibility in those who are being trained for leadership in the engineering sciences. It feels that its duty is to translate that philosophy into practical terms and to apply it as an essential part of the education and training of the students of the engineering schools at Cooper Union.

Translating its broad aims into specific objectives the Department feels that there are three main functions which it must perform:

1. It must provide a background for the proper understanding of the present day social world.

2. It must teach certain skills of a non-technical nature which will make the application of technical knowledge more efficient.

3. It must develop a respect for and an appreciation of those values which mark the cultured and civilized human being.

The major changes in the curriculum have been made with these ends in mind. Moreover, in making them, consideration has been given to the need of a program integrated enough to achieve the objectives efficiently and at the same time elastic enough to include the best of what already has been done and to allow for expansion in terms of additional courses and effort hours.

In the Freshman year of the Day School, five hours of class work plus five hours of preparation have been allotted to the Humanities. These hours are being devoted to a study of Western Civilization and English Composition. The class meets as a whole for one hour and in sections for the other four. In Western Civilization the emphasis is placed on the social, economic and intellectual history of Europe and the United States since the breakup of the Middle Ages. Along with its study of the history of the modern period, the class becomes acquainted with the important contemporary figures of literary and social significance. The meeting of the class as a whole once a week is devoted to a lecture in which the instructor attempts to sketch out broadly some specific area of historical or literary importance. If, for example, the French Revolution is under consideration, the lecturer, not unmindful of the tumbrils and guillotine, points out the scientific and intellectual revolutions that preceded the events of 1789, and stresses the connection with the middle class revolts of 1688 in England and 1776 in America. Then in the section meetings the student is encouraged to discuss these events, using his texts as handbooks of references for factual data and his readings of such works as Voltaire's "Candide" or Rousseau's "Social Contract" for a finer understanding and appreciation of what hitherto has been a succession of unrelated facts.

At the same time the theory and practice of English Composition, for which one hour is set apart, is correlated by using as subjects of oral and written themes topics drawn from Western Civilization. In addition the transfer value of freshman composition is increased by weekly sample checks of freshman physics laboratory reports.

The freshman course has been designed to serve as an introduction and not as something definitive. It is the feeling of the Department that from it the student should be directed to continue with as much freedom as possible along the lines in which his interest has been awakened. If he has found history a subject cap-

able of widening his vision he should have a choice of courses in which he can delve more deeply into the events and patterns of some significant era. If he has discovered that great books give him understanding, then he should have the opportunity to explore literary fields wherein he may find joy and wisdom. It is hoped, therefore, that eventually the Humanities staff will be permitted to offer a wide variety of subjects from which the student may elect to pursue a reasonably self-determined field for study.

As a first step towards this goal, the sophomore may choose a half year's work in American Government or a half year of American Literature. If he elects literature he studies the literary developments in America in relation to the background of European literature and of social influences operating in America. If he chooses government, he surveys the present day structure and function of the national and local governments of the United States.

The other semester, the second year student devotes to Public Speaking, in which course he receives practice in oral English and speech to the end that he may acquire poise, self-confidence and the ability to use the language free from startling variants of local origin. Although this subject was introduced in September, and hence has been a part of the curriculum only a short time, it already comes under the heading of "required subjects." Probably no course has been as warmly welcomed by the engineering departments as this one. Its title is a poor one for between it and the elocution which it so often connotes there is little connection. Instruction emphasizes not speech-making but discussion and conversation, pointed, direct and confident. Supplementing the class room hours, the instructors in Public Speaking visit those engineering classes in which oral reports are given. Here they receive cordial welcome from engineering professors long distracted by bad habits and hesitancies of speech.

By virtue of his special needs, the Chemical Engineer studies German during his second year. This course has been revamped to some extent in order that its cultural value might be enhanced, by requiring in addition to scientific German a rapid reading of some literary German. Moreover in order to acquaint the student with the great wealth of German history, literature and culture there has been formed a German Club which meets informally to talk in German about pre-Hitler German Kulturkunde.

In order to introduce the student to the basic principles of economic problems, a two hour course in Economics is taken by the third year student. This course has been revised recently, brought up to date and is modelled after a similar course at M. I. T. where it has proved successful.

The senior year in Humanities is devoted to the Colloquium in Social Philosophy, introduced last year largely out of the instructor's personal experience with the General Honors Course at Columbia College and various reading groups which were carried on for some years by the Peoples Institute at Cooper Union. It proved its success last year and is being continued this year. In the colloquia which meet in small groups the seniors discuss questions of logic, psychology, philosophy and literature based on their readings of well-chosen and stimulating books, such as, Sarton's "The History of Science and the New Humanism," Bacon's "The New Atlantis," Stebbing's "Thinking to Some Purpose," Smith's "On Reading Shakespeare," Plato's "The Symposium," Hayes' "Essays on Nationalism," and Russell's "Power." The sections are purposely kept small, averaging about a dozen students who come together in an easy informal manner as devoid of the conventional class room atmosphere as limited facilities permit.

In the Night School two class hours per year for five years are allotted to the Department of Humanities. Unlike the usual English composition course, the Freshman work is based on American history and literature: an attempt is made to give the student an understanding of the forces which have brought about the social and political development of the United States. Readings in American history take the place of the more conventional readings found in most colleges. Thus, as in the Day School's course in Western Civilization, practice in writing and speech becomes a means of achieving not only a clear and cogent style of expression but also a background for social awareness. This integration of history and English calls for much effort and alertness from the instructors but that they have met the challenge is evidenced in the frequent expressions of regret by upperclassmen that they did not have the course as freshmen.

Together with the introduction of sociology in the second year and of economics in the fourth, the first year course just described constitutes the most radical change in the Night School. Other courses are designed largely to give specialized training in accounting, engineering law, etc. These have tremendous value especially to Night School students who are already in industry. However, they must be supplemented in the immediate future by wider training in the arts, literature and social sciences.

The above in short is what is being done in the Schools of Engineering. In a school such as Cooper Union, situated in a metropolitan area, the problems which a Department of Humanities is meant to remedy are much more acute than in less populous, less urban areas. That this is true is revealed by the results of a

testing program which the Department has completed. On the basis of standardized cultural background tests it has been discovered that Cooper Union freshmen have a much greater knowledge of science and mathematics than the average student of Class A colleges. Their accomplishments in English and the social sciences however fall far below their extremely high standards in the natural sciences. These conclusions indicate very clearly the need for an expanded program of humanities. The long hours of commuting provide time for the student's perusal of newspaper headlines from which he gets only the most superficial knowledge of the social sciences. Such a situation makes imperative a course of study that will give him the background necessary for mature judgment and understanding. At the same time the professional associations which he must make in order to be successful and happy are closer knit when he can possess and share in that heritage of literature and arts which is the hall-mark of a cultured person.

To find the best method whereby the Cooper Union student of engineering can achieve this background and familiarity within the exacting limits of time and facilities is what the Cooper Union Department of Humanities regards as its chief justification for its experiments and innovations.

MECHANICAL ENGINEERING PAGE

Those who personally dominate are heroes for the hour; those who build men are immortals.

R. L. SWEIGERT, Georgia School of Technology, *Editor*

SOME NOTES ON THE BERKELEY MEETING

The Mechanical Engineering Committee has planned a comprehensive program for the Berkeley meeting that should satisfy the wide variety of interests that exists amongst the membership of the Mechanical Engineering Division. There are contributions from both engineering educators and from men in industry.

There are papers on Power Plant Design, Machine Design, Junior Courses in Heat Power Engineering, Teaching of Materials in a Process Course, A Standard Gage Laboratory, Unit Operation Instruction in Mechanical Laboratory Instruction, Heat Transfer Instruction, Economics and Mechanical Engineering, and The Technique of Inventing.

A periodic reevaluation of the objectives of the various fields making up Mechanical Engineering is necessary to enable us to effectively chart our course in Mechanical Engineering Education. Such a paper, entitled "Objectives of Instruction in Machine Design," is being presented by C. F. Garland and E. E. Weibel of the University of California.

"Teaching Materials in a Process Course," by R. E. Kyle of the Massachusetts Institute of Technology, is another paper emphasizing the new developments in Manufacturing Processes Laboratories. There is no phase of Mechanical Engineering Education that has been making more progress in recent years.

"Unit Operation Apparatus in Mechanical Laboratory Instruction," by R. A. Seban of the University of Santa Clara, seems to be an enticing topic whether we might be in favor of or opposed to such an arrangement.

"Heat Transfer Instruction in Heat Power Courses," by E. D. Howe of the University of California, is another interesting subject. Heat transfer should occupy a strong position in Mechanical Engineering Education, but at present, instruction in heat transfer is weak at nearly all institutions.

A joint session of the Mechanical Engineering Division and the Committee on Engineering Economy is planned for June 27. Dr. Muir of the General Electric Company is going to talk on "An Industrial View of College and Post College Engineering Education." This should prove to be a timely topic. One day will be spent visiting Stanford University at Palo Alto.

And since everyone is interested in the eating program, a preview of the 1940 program would not be complete without mentioning the annual M. E. dinner Tuesday evening, June 25, and the annual luncheon Thursday noon, June 27. The luncheon program is light and reminiscent, while the dinner program will take on a bit of formality in the presentation of the newly elected officers of the Division, and the present plans of the committee call for President W. H. McBryde of the A. S. M. E. as the principal speaker at the dinner.

Once again the Division Committees have prepared a fine program for the enjoyable and profitable experiencing of the M. E. membership.

THE T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF THE
DIVISION OF ENGINEERING DRAWING

A. W. LEIGHTON, *Editor*, Tufts College

SELLING THE TANGIBLES

Professor Brown's excellent article in the March issue of the JOURNAL OF ENGINEERING EDUCATION presents an interesting and valid argument for "selling the intangibles." This, however, is not a new conception of some of the objectives in the teaching of descriptive geometry. We have been trying to sell intangible benefits for over a century, but we have not been notably successful in selling them to our former students who are now college administrators and the makers of curricula for the engineering degrees. The result has been that there has been a steady reduction in the amount of time allowed for this important subject, and in some cases they have cut the dog's tail off just behind his ears. The authors who present a large number of practical applications probably are not trying to "save the face" of descriptive geometry, but on account of unwarranted attacks upon the subject, they are trying to save its body and soul.

We should not lose sight of the fact that Gaspard Monge created descriptive geometry to simplify the solution of some practical problems, and in doing so sold his subject to the engineering world. Since he was primarily a mathematician, it was natural that he should have developed the subject along mathematical lines. Almost immediately some of the intangible objectives were given as sufficient reasons for including the subject as a part of all engineering curricula. Although experienced teachers recognize these objectives and appreciate the mathematical foundations, the fact remains that descriptive geometry is essentially a graphical method of solving engineering problems of space.

Granting that it is possible that a few teachers may have overlooked emphasizing fundamental principles in their enthusiasm for practical applications, this writer does not believe that they have turned to this method in desperation. Neither does he believe that anything worthy of the name, descriptive geometry, can be "too easy and popular." The subject has suffered more from being considered too hard and impractical, and there is some justification for this point of view if a large portion of the course has been devoted to learning to work in each of the four angles, and in attempting to master the intricacies of the traces of planes which the student never heard of in a drawing course and probably could not use in the practical problems of the drafting room. He can be sold on a practical course, and will stay sold.

Unfortunately in many cases the time allowed for a course in descriptive geometry is too short for full coverage, and few students are able to attain that masterful knowledge necessary for the solution of unusual new problems. If they have not applied the principles to the solution of many concrete examples, they may even fail to see that the methods of descriptive

geometry are available. Practical applications serve as effective illustrations of fundamental principles. The instruction is received in much better spirit because it is more interesting and gives tangible evidence of the value of the subject.

C. E. Rowe

Professor of Drawing, the University of Texas

IMPORTANT INFORMATION

National Drawing Competition, 1939–1940

Auspices of the Division of Engineering Drawing and Descriptive Geometry, S. P. E. E.

1. The mimeographed classification cards are to be made out in triplicate for each drawing submitted; one to be sent with the submitted drawing, as indicated in Paragraph 2 below, one to be kept in the instructor's files, and the third to be sent to the Chairman of the Competition Committee.

2. Each submitted drawing must be accompanied by one classification card. Put classification card, completely filled out, in an envelope and attach it to the drawing. On outside of envelope give Entry Number and Class in which the drawing is entered.

3. Pack drawings Flat and wrap carefully so that they will arrive in perfect condition.

4. Send drawings by Railway Express, *Prepaid*. All entries not placing will be returned by Railway Express, *Collect*.

5. Send drawings to arrive in Berkeley, California, not later than Saturday, June 15, 1940. Drawings, however, should be sent well in advance of above date.

6. Send drawings addresed to:

Professor H. B. Langille,
S. P. E. E. Drawing Competition,
University of California,
Berkeley, California.

NECROLOGY

ISAAC NEWTON CARTER, Professor of Civil Engineering at the University of Idaho, died suddenly April 8, 1940, in Moscow, Idaho. His going was a great shock to the College of Engineering not only because of its suddenness, but also because of his long service at the University of Idaho.

Professor Carter was born in Bonham, Texas, in 1891. His undergraduate training was obtained at the Rice Institute of Texas, the University of Colorado, and the University of Idaho. He graduated from Idaho with the degree B.S. (C.E.) in 1925, but started his teaching career at this University in 1923, two years before he received his bachelor's degree in Civil Engineering. In 1927 he received his M.S. degree and in 1930 his professional degree as a Civil Engineer, both from the University of Idaho. His teaching record at Idaho was rather unique in that he started as a student instructor and progressively filled the various ranks up to and including a full professorship in Civil Engineering.

Professor Carter's special interests were engineering drawing, descriptive geometry, and sanitary engineering. His book entitled "Engineering Drawing, Theory and Practice" was published in 1938 by the International Textbook Company. This book received favorable comment and some outstanding adaptions. A manual entitled "Engineering Problems," with Arthur J. Davidson of the University of Idaho as coauthor, was also published in 1938.

Professor Carter was a member of S. P. E. E., having joined in 1925 and was active in the A. S. C. E. and the Pacific Northwest Section of the American Water Works Association.

JAMES ALFRED REYNOLDS, Assistant Professor of Electrical Engineering at Tufts College, died suddenly during the evening of April 5, at the age of 53. Professor Reynolds was born in Stoneham, Massachusetts, and was graduated from Tufts College Engineering School in 1910. He entered the training course of the General Electric Company at Schenectady, N. Y., completed the course, was assigned to the testing department, and soon became Chief of Tests. In 1919 he returned to Tufts College as Instructor, and later was appointed Assistant Professor of Electrical Engineering. Professor Reynolds took a prominent part in the civic life of his city, Somerville. He had served as Chairman of the Board of Health, and at the time of his death was a member of the Board of Welfare. The College and the larger community have suffered a real loss in his passing.

NEW MEMBERS

BAKER, RALPH D., Assistant Professor of Mechanical Engineering, University of Utah, Salt Lake City, Utah. A. Diefendorf, A. L. Taylor.

BARNES, JOHN S., College Representative, John Wiley & Sons, Inc., 440 Fourth Ave., New York City. F. L. Bishop, Nell McKenry.

BENNETT, HARRY F., District Engineer, Dept. of Public Works, Box 668, London, Ont., Canada. R. D. L. French, C. M. McKergow.

BILLINGS, ERLE M., Business and Technical Personnel Director, Eastman Kodak Co., 343 State St., Rochester, N. Y. F. L. Bishop, Nell McKenry.

BLOEM, HENRY P., Instructor in Engineering, South Dakota State College, Brookings, S. D. B. M. Aldrich, W. M. Becker.

BOLT, JAY A., Instructor in Mechanical Engineering, University of Illinois, Urbana, Ill. J. C. Miles, O. A. Leutwiler.

BOWMAN, RICHARD S., Instructor in Humanities, Cooper Union, New York City. G. F. Bateman, W. S. Watson.

BRAGG, FRANCIS C., Instructor in Technical Drawing, Syracuse University, Syracuse, N. Y. L. B. Howe, G. B. Smith.

CECIL, JESSE B., Instructor in Engineering Mechanics, University of Nebraska, Lincoln, Nebr. J. W. Haney, O. J. Ferguson.

EBERHART, HOWARD D., Assistant Professor of Civil Engineering, University of California, Berkeley, Calif. R. E. Davis, H. E. Davis.

EMERY, KENNETH G., Teaching Fellow in Mechanical Engineering, University of Michigan, Ann Arbor, Mich. H. E. Keeler, A. H. White.

FIEDLER, GEORGE J., Associate Professor of Electrical Engineering, Montana State College, Bozeman, Mont. E. W. Schilling, M. R. Good.

HUDSON, ROSS C., Associate Professor of Civil Engineering, Clarkson College of Technology, Potsdam, N. Y. W. H. Allison, H. A. Weiss.

HULL, WILLIAM L., Instructor in Mechanical Engineering, Purdue University, Lafayette, Ind. W. J. Cope, H. L. Solberg.

HUMPHREY, ELMER N., Instructor in Agricultural Engineering, University of Idaho, Moscow, Ida. J. E. Buchanan, F. L. Bishop.

HYDE, CHARLES G., Professor of Sanitary Engineering, University of California, Berkeley, Calif. B. M. Woods, B. F. Raber.

MARTINSON, NORMAN L., Instructor in Mechanics, Rensselaer Polytechnic Institute, Troy, N. Y. L. W. Clark, R. H. Trathen.

MAUTE, BERNHARD W., Instructor in Machine Design, Stevens Institute of Technology, Hoboken, N. J. W. R. Halliday, F. D. Furman.

MESSERSMITH, CHARLES W., Assistant Professor of Mechanical Engineering, Purdue University, Lafayette, Ind. W. J. Cope, D. L. Arm.

MITSCH, JOHN D., Assistant Professor of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Mass. E. Mirabelli, C. B. Breed.

PETERSON, DEAN F., Instructor in General Engineering, University of Washington, Seattle, Wash. E. R. Wilcox, Alfred Jensen.

PETERSON, EARL H., Assistant Professor of English, Kansas State College, Manhattan, Kansas. M. W. Furr, L. E. Conrad.

PETTIT, JOSEPH M., Instructor in Electrical Engineering, University of California, Berkeley, Calif. L. F. Fuller, E. D. Howe.

RIZZI, ANTHONY V., Tutor in Civil Engineering, College of the City of New York, New York City. S. J. Tracy, Wm. Allan.

SIBLEY, ALDEN K., Engineer of Construction, U. S. Engineers Office, Caddoa, Colo. F. H. Sibley, W. O. Wagner.

WINTERKORN, HANS F., Research Associate in Soils, University of Missouri, Columbia, Mo. Harry Rubey, M. W. Furr.

WISEMAN, EUGENE R., Assistant Professor of Mechanics, Rensselaer Polytechnic Institute, Troy, N. Y. L. W. Clark, R. H. Trathen.

THE COLLEGE OF THE CITY OF NEW YORK, New York, N. Y., A. B. Newman, Acting Dean.

340 new individual members plus 5 institutional.

NECROLOGY

Walter S. Rugg was born April 3, 1866, in Broadhead, Wisconsin, and died suddenly in New York on April 25, 1940. He was graduated from Lawrence College, B.S. 1886, and from Cornell University, M.S. 1892. In June of that year, he entered the employ of the Westinghouse Electric & Manufacturing Company as a student, later entering the Engineering Department, first at the East Springfield Works of the Company, then in Chicago, and later in New York. He was Manager of the Westinghouse New York Office from 1909 to 1917; Manager of the Railway Sales Department, 1917 to 1920; Assistant to Vice President, 1920 to 1922; General Sales Manager, 1922 to 1925; and Vice President from 1925 to the time of his retirement in 1935. During a portion of his vice presidency, he was in responsible charge for some time of the sales activities of Westinghouse, and then for some time in charge of the engineering activities, and subsequently for a period in charge of both of these important branches.

Mr. Rugg's interest in engineering education was sustained throughout his professional career. Very much of the progress made by Westinghouse in its Graduate Student Training Course and in relation to its development of the coöperative graduate work was due to the stimulation and continuing interest which he gave that work.

Mr. Rugg, in addition to his membership in the Society since 1926, was a member of the American Institute of Electrical Engineers, the American Field Society, and the Franklin Institute.

SECTIONS AND BRANCHES

Following registration the Ninth Annual Meeting of the **Missouri Section** convened at the Missouri School of Mines, April 6, 1940, where they were called to order by the President, Dean Harry A. Curtis. Director Wm. R. Chedsey gave a short address of welcome, after which the report of the nominating committee was received. The following men were nominated and unanimously elected officers for the coming year:

Jules Bebie, Washington University, *President.*
W. T. Schrenk, Missouri School of Mines, *Vice-President.*
R. B. B. Moorman, University of Missouri, *Secretary.*

The dinner meeting was held at the Sinclair Pennant Tavern at 6:00 P.M. The speaker at this meeting was Professor J. Brewton Berry, Department of Sociology, University of Missouri. The subject of his address was "Looking Backward."

Letters of thanks have been sent to the speaker, Professor J. Brewton Berry, and to the following committee chairmen:

Registration—Professor H. H. Armsby.
Luncheon and Dinner—Professor I. H. Lovett.
Entertainment of Ladies—Mrs. Wm. R. Chedsey.

F. H. FRAME, *Sec. 1939–40*

The S. P. E. E. Branches of **Northeastern University** and **Tufts College** held a joint dinner meeting at Northeastern on Monday, March 11, 1940. Fifty-three members were present. The theme of the meeting was "What is Being Done for the Professional Development of the Recent Engineering Graduate." President C. P. Baker introduced Mr. Holcombe Brown, president of the Engineering Societies of New England, who brought the greetings of his Society.

Professor J. W. Zeller, Chairman of the Department of Mechanical Engineering at Northeastern, discussed the activities in other localities toward professional development. The period between graduation and the establishment in industry of the young engineer is critical. Here, guidance of a professional society can be most valuable. The percentage of junior members to total membership is low in all professional societies. Efforts to increase the junior membership have not been entirely successful.

Professor Edgar MacNaughton, Chairman of the Department

of Mechanical Engineering at Tufts, outlined the activities toward professional development in Greater Boston.

There is need for more co-operative effort by industry and the engineering colleges to help the graduate in his adjustments between college and industry. Much can be done by the professional societies. They may:

a. Prepare a list of suggested readings.

b. Make junior members more welcome at professional society meetings.

c. Invite junior members to arrange the program and run certain meetings.

d. Schedule two or three meetings each year of especial interest to junior members.

Mr. James Moyer, Director of the Massachusetts University Extension Service, spoke concerning the educational courses available in Greater Boston to the recent engineering graduate. The courses offered are both liberal and technical and are conducted both in class and by correspondence. Approximately 2,000 technical graduates are currently enrolled.

An active forty-minute discussion period followed the presentation of the three speakers. Several conclusions were expressed:

a. The present plight of the young technical graduate is not a transitory phase but is a part of a broad social change.

b. Unless able, constructive leadership is supplied, a less desirable form of leadership is certain to develop.

c. The established professional societies are the best source of this constructive leadership.

d. Activities and attitudes which encourage the participation of potential and existing junior members should be developed.

e. These efforts should lead toward close association with the parent society rather than to the formation of another group within the society.

The meeting was adjourned at 8:40 P.M.

WILLIAM T. ALEXANDER, *Secretary,*
Northeastern University Branch

COLLEGE NOTES

Carnegie Institute of Technology.—The Eleventh Eastern Photoelasticity Conference will be held on May 24th and 25th at the Carnegie Institute of Technology, Pittsburgh, Pa. An interesting program is being arranged dealing with the latest developments in the field of photoelasticity.

University of Louisville.—Ground was broken on February 14th for a new $200,000 engineering building for the Speed Scientific School. This building, of early American architecture designed by J. Frederick Larson, Hanover, N. H., will be the first of a future engineering group on the university campus. It will adequately house the departments of chemistry, English, mathematics, drawing and chemical engineering, as well as the administrative offices, engineering library and auditorium. Future buildings on the same site will house the departments of civil, electrical and mechanical engineering.

Speed School's new building was made possible by a gift from Mr. William S. Speed and his sister, Mrs. Olive Speed Sackett, as a memorial to their father, the late James Breckenridge Speed, pioneer Louisville and southern Indiana industrialist. It will be constructed with W. P. A. aid.

The first Speed School surveying camp was held March 16 to 23, 1940, during the Spring vacation. Attendance was on a voluntary basis, a total of 35 students attending. The camp was held at the Otter Creek Recreational Development Project, a National Park Service development, West Point, Ky. About 500 acres of the 3,300 acre tract was mapped on a scale of one inch equals four hundred feet, with a contour interval of ten feet. The camp was a decided success and next year's attendance should be much larger. Professor George H. Harding was the camp director.

Professor W. R. McIntosh, of the civil engineering department, has been appointed as resident engineer on the new engineering building and has been given a leave of absence from teaching duties. His position on the faculty has been filled by the temporary appointment of Mr. Myron L. Gossard, B.S., M.S., Illinois, as instructor in civil engineering. Mr. Gossard had been teaching at the Iowa State College.

University of Michigan.—Ivan C. Crawford, distinguished military engineer and a member of the University of Kansas fac-

ulty since 1937, was named Dean of the College of Engineering effective July 1, 1940. Dr. Crawford's appointment fills a vacancy which has existed since the death of Dean Henry A. Anderson on Oct. 14, 1939. He will become the fifth dean since the engineering college was founded in 1895.

Dean Crawford taught for nine years in the engineering college of the University of Colorado, and was made Dean of the engineering college at the University of Idaho in 1923. In 1937 he became Dean of the school of engineering and architecture at the University of Kansas.

The College of Engineering will sponsor an Internal Combustion Engine Institute during the coming Summer Session. A series of special lectures will be given by outstanding men from industry who are active in this field. This is in line with the policy of the college under which Institutes of Electronics and Engineering Mechanics have been sponsored during the past ten years.

During the coming summer special courses will be given in Advanced Thermodynamics by Professor J. H. Keenan of Massachusetts Institute of Technology, the Design of Internal Combustion Engines and Diesel Power Plants by Professor E. T. Vincent of the University of Michigan, and advanced courses in Dynamics, Strength of Materials, Vibration Problems, Stress Analysis and Plasticity will be given by Professors E. L. Eriksen, Jesse Ormondroyd and J. A. Van den Broek of the University of Michigan, and Dr. S. P. Timoshenko of Leland Stanford University.

The Department of Engineering Mechanics will likewise conduct a symposium on Vibration Problems during the coming Summer Session under the direction of Dr. S. P. Timoshenko. This is sponsored by the Timken Roller Bearing Company and the University of Michigan.

The following appointments have been announced at **Tufts College** in the Department of Chemistry and Chemical Engineering: Professor H. Marshall Chadwell, Chairman of the Department; Professor Crosby F. Baker, Secretary of the Department and Curator of the Pearson Memorial Laboratory; Professor David E. Worrall, Director of the Chemical Laboratory.

BOOK REVIEWS

Handbook of Refrigerating Engineering. W. R. WOOLRICH. D. Van Nostrand Company, Inc. Twenty-five chapters, 425 pages.

Chapter one of the book covers fundamental refrigeration definitions. Subsequent chapters discuss food preservation and cold storage, refrigerants, ammonia, ammonia compression systems, the condenser, refrigerator systems, heat transfer and insulation, thermodynamic equations, constants, and calculations, electric refrigeration plants, the absorption method of refrigeration, absorption machine operation, carbon dioxide, sulphur dioxide, characteristics of other refrigerants, ice and ice making, special absorption units, air cooling and conditioning, testing the refrigeration plant, freon (F–12), methyl chloride, refrigeration in the dairy industry, quick freezing of foodstuffs, storage of meat, and supplementary tables.

The book is well written in simple engineering terms and as a handbook would fit the needs of a person interested in the general fundamentals of refrigeration engineering.

F. H. S.

Electric Transportation. FRANCIS R. THOMPSON, 425 pages. International Textbook Company, Scranton, Pennsylvania, 1940. $4.00.

Recent developments in the electric transportation field include trains especially designed for high-speed, long-distance service and propelled by electric locomotives carrying their own electric generating equipment. During the same period, city, interurban and suburban services have been improved by means of new electric cars and electric buses designed both for appearance and comfort and also to meet service conditions.

This new book, which is intended primarily for engineers and personnel in the electric transportation field and for design engineers of manufacturing companies, is timely in view of the recent important developments and improvements in the field of electric transportation. It discusses both the customer's and the operating company's viewpoints in regard to what should be considered good electric transportation services.

There are many charts, diagrams, and well selected illustrations of electric transportation equipment. The study of the application of electric equipment in the several major transportation divisions is comprehensive and up-to-the-minute. The chapters of

the book are: Historical Background of Transportation, Mass Transportation, City Service Cars, Trolley Buses, Self-Propelled Electric Buses, Field of the Mass-Transportation Vehicles, Rapid Transit, Calculating the Performance of the Electric Car, Railway Motors, Railway Gearing, Railway Control, Brakes, Current Collectors, Electric Locomotives, Heavy Traction Cars, Self-Propelled Rail Motor Cars, Railway Substations, and Contact Systems.

The book is not laid out for class work and there are no problems; however, the book is well organized and clearly written and should, therefore, serve as a satisfactory text for senior and graduate courses in electric transportation in engineering colleges. A good command of electric circuits and machinery would be required on the part of the student and testing experience with several types of electric transportation equipment discussed in the book would be desirable on the part of the instructor.

BERTRAM K. HOVEY

The Fundamentals of Electromagnetism. E. G. CULLWICK. New York: The Macmillan Co. Cambridge: The University Press. First edition. 352 pages. Price $4.50.

Professor Cullwick has presented a somewhat different viewpoint on the subject of electromagnetism which, although not new, is at least presented in a form that can be evaluated and appreciated by the electrical engineer. The physical concept of unit poles and charges has been the standard method of presentation of the subject in engineering text books for many years.

It may be questionable whether there is any serious confusion in the average undergraduate student's mind over his inability to prove "definitions in terms of impossible experiments on non-existent unit poles." It would seem well, for the present at least, to hold to the present means of explaining the basic phenomena and then at a later date, after the student has had a broader view of not only more advanced mathematics including vector analysis but perhaps an insight into quantum mechanics, return to this newer viewpoint. This, of course, is a more conservative approach to the matter, but its value can be determined only from experience.

The Fundamentals of Elecetromagnetism is clearly written in a logical manner and contains many solved and unsolved examples which should prove of value in clarifying this new approach.

H. E. DYCHE

Air Conditioning. First Edition. BURGESS H. JENNINGS AND SAMUEL R. LEWIS. International Textbook Company. Eighteen chapters, 467 pages.

An extremely well-written book with the material arranged in a very logical manner. The first part reviews the background or fundamentals of air conditioning and presents the thermodynamics applying to the subject. Ample tables and practical test information are provided and in general this combination makes possible a very thorough understanding of the essentials of the subject. Various types of heating systems are explained with problems to illustrate the application of the theory involved. A basement plan of the duct work for a forced draft warm air heating system is shown with sizes of ducts indicated and tables, charts, and sketches are included to illustrate the analysis of a heating problem of this type. The chapter on fluid flow is attractively written, presenting the basic principles involved and also the practical aspects such as register location in a distribution system for both cooling and heating systems. Chapter fifteen presents a rather complete description of the refrigeration phase of air conditioning work, illustrating various types of equipment and presenting various refrigerant thermodynamic charts. The information presented covering methyl chloride and ammonia could no doubt be omitted as not being essential in the study of the subject and the addition of performance charts on freon compressors and cooling coils would no doubt be a valuable addition to this book.

F. H. S.

Electricity and Magnetism. JOHN B. WHITEHEAD. McGraw-Hill Book Co., Inc. First Edition. 15 chapters. 221 pages.

Professor Whitehead has done a commendable piece of work in his *Electricity and Magnetism.* The logical order of development of electrostatics and magnetism from basic laws to useful formulae and circuits make the text ideal for undergraduate electrical engineering students beginning the study of circuits. Mathematics has been used to sufficient extent to develop needed relations, while the author's clear and logical explanations in terms of both the electron theory and the practicality of the work should aid the student greatly in visualizing and obtaining a better grasp of the material.

The chapter on units is important as it coördinates the three systems now in use and includes dimensional equations whose importance cannot be over-estimated. The value of the chapters on A.C. circuits and the conduction of electricity in gases may be questionable for a course for which this book would be used. Perhaps

it would be better to replace these sections by an expansion of the transients chapter and reserve these other subjects for their separate courses. For class use the instructor will probably find the absence of problem lists a slight inconvenience.

H. E. DYCHE

Design of Machine Members. First Edition. ALEX VALLANCE. McGraw-Hill Book Company, Inc. 514 pages.

In common with many machine design texts, the first four of the twenty-three chapters in this book present a review of strength of materials, materials of construction, working stresses and factor of safety. The chapters on riveted and welded joints are amply described and illustrated. The remaining chapters cover bolts and screws, keys, cotters, and knuckle joints, cylinders, pipes, and tubes, flat plates and cylinder heads, springs, shafts, couplings and clutches, brakes, sliding bearings, roller and ball bearings, belts and belt conveyors, rope drives, hoisting and power chains, toothed gearing on parallel shafts, bevel and worm gears, metal fits and tollerances, miscellaneous machine members, etc.

The last chapter of the book includes four hundred and ninety-five problems applicable to the various chapters. In general the text covers the subject in a very complete manner.

F. H. S.